SOUTHWESTERN
RANGE & SHEEP BREEDING LABORATORY
FORT WINGATE, NEW MEXICO

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
COOPERATING WITH THE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
AND THE
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

1953-54 18 REPORT

FIRST BIENNIAL

THIS REPORT OF RESEARCH PROJECTS NOT YET COMPLETED IS INTENDED FOR THE USE OF ADMINISTRATIVE LEADERS AND WORKERS IN THIS OR RELATED FIELDS OF RESEARCH, AND NOT FOR GENERAL DISTRIBUTION.

ROSTER OF PERSONNEL

Name	Title	Date entered on duty	Duties
Stanley L. Smith	Animal Husbandman	Jul. 23, 1952	Director
George M. Sidwell [1]	Animal Husbandman	Dec. 1, 1946	Genetics
Gordon L. Jessup, Jr.	Animal Husbandman	Mar. 17, 1952	Sheep Investigations
Vern B. Swanson [2]	Animal Husbandman	Apr. 10, 1951	Sheep Management
Alison S. Dodge	Clerk-Stenographer	June 3, 1951	Clerical
Glenn C. Perkins	Farm Foreman	Sept. 24, 1954	Operations
Jimmie Gleason	Maintenance Man	Apr. 1, 1942	Maintenance
Marion Chadacloi [3]	Laboratory Aid	Jan. 12, 1944	Miscellaneous
Fred Deschene	Labor Leader	Oct. 2, 1947	Camp Tender
Alfred Dempsey [4]	Maintenance Man	Dec. 23, 1947	Miscellaneous
Homer Dick	Laborer	Apr. 7, 1953	Miscellaneous

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1. Dr. George M. Sidwell moved to the New Mexico Agricultural Experiment Station, State College, New Mexico, March 1, 1954 where he is engaged in sheep breeding research of interest to both the New Mexico Station and the Sheep Breeding Laboratory. He also serves to coordinate the activities in sheep breeding research of the two institutions.

2. Entered on Leave Without Pay September 12, 1954

3. Resigned February 27, 1953

4. Transferred to Bureau of Indian Affairs, September 30, 1954

OBJECTIVE

The main objective of this laboratory is the development of types of sheep which are adapted to the semi-arid range conditions of the southwest, and to the economic requirements of Navajo Indians and other sheepmen of this area. In the pursuit of this objective, basic breeding methods are employed, utility values of the wool are studied and the selection of breeding animals is based upon production as measured under range environment. Emphasis is placed primarily on adaptability and longevity of the sheep, yield of wool and its suitability with respect to hand weaving and commercial manufacture, and the quantity and quality of lambs produced.

OUTLINE OF RESEARCH PROGRAM

In order to achieve the above objective in the development of breeds and strains of sheep suitable to the southwestern ranges and to the economic requirements of the sheepmen, there are four active research projects under way. These projects are carried out under U. S. Department of Agriculture Work Projects ARS-b-2-1, Sheep Breeding Investigations and ARS-b-2-6, Investigations of Wool and Other Animal Fibers. The four projects at Fort Wingate are as follows:

1. Improvement of Navajo sheep by linebreeding and selection in the Navajo strain.

2. Improvement of Navajo sheep by crossbreeding and selection for the production of wool suitable for both hand and commercial methods of manufacture.

3. Improvement of Navajo sheep by crossbreeding and selection for range production of wool and lambs.

4. Development of an efficient method of selecting animals used in the program of the Southwestern Range and Sheep Breeding Laboratory.

(NOTE: When reference is made to the above projects in the following sections of this report, only the number preceding the project title will be used.)

PUBLICATIONS

The following papers have been published since the establishment of the Southwestern Range and Sheep Breeding Laboratory:

1. The Navajo Sheep Industry and Needs for Its Improvement:
   J. M. Cooper, the Sheep Breeder, May 1939.

2. The Sheep Industry of Indians in the Southwest:
   J. M. Cooper and Dewey Dismuke, Indians at Work, August 1939.

3. Breeding for Adaptability to Local Conditions, with Special Reference to Sheep on the Navajo Indian Reservation:
   J. M. Cooper, American Society of Animal Production, 1939.

4. Improvement of the Navajo Sheep:
   Cecil T. Blunn, Journal of Heredity, March 1940.

5. Breeding for Quality Wool:
   James O. Grandstaff, The National Wool Grower, July 1940.

6. A Rapid Method for Projecting and Measuring Cross Sections of Wool Fibers: James O. Grandstaff and Walter L. Hodde, Circular No. 590, U. S. Department of Agriculture, December 1940.

7. Evaluating Fleece Characteristics of Navajo Sheep from a Breeding Standpoint:
   James O. Grandstaff, Rayon Textile Monthly, October-November 1941.

8. Wool Characteristics in Relation to Navajo Weaving:
   James O. Grandstaff, Technical Bulletin No. 790, U. S. Department of Agriculture, January 1942.

9. Characteristics and Production of Old-Type Navajo Sheep:
   Cecil T. Blunn, Journal of Heredity, May 1943.

10. The Influence of Seasonal Differences on the Growth of Navajo Lambs:
    Cecil T. Blunn, Journal of Animal Science, February 1944.

11. A preliminary Report on the Post-Natal Develpment of the Fiber Characteristics of the Fleeces of Navajo Sheep:
    James O. Grandstaff and Cecil T. Blunn, Journal of Animal Science, May 1944.

12. Comparison of the Yields of Side Samples from Weanling and Yearling Sheep:
    Cecil T. Blunn and James O. Grandstaff, Journal of Animal Science, May 1945.

13. Yearly Differences in Growth of Navajo and Crossbred Ewe Lambs:
Cecil T. Blunn, Journal of Animal Science, Agust 1945.

14. Evaluating Fleece Quality of Navajo Sheep from Small Samples:
James O. Grandstaff and Cecil T. Blunn, Journal of Agricultural Research, September 1945.

15. Improvement of Wool for Navajo Hand Weaving:
James O. Grandstaff and Cecil T. Blunn, Indians at Work, March 1945.

16. Relation of Kemp and Other Medullated Fibers to Age in the Fleeces of Navajo and Crossbred Lambs:
James O. Grandstaff and Harold W. Wolf, Journal of Animal Science, May 1947.

17. Comparison of Corriedale x Navajo and Romney x Navajo Crosses:
James O. Grandstaff, Journal of Animal Science, November 1948.

18. Size of Lambs at Weaning as a Permanent Characteristic of Navajo Ewes:
George M. Sidwell and James O. Grandstaff, Journal of Animal Science, August 1949.

19. Adaptation of Livestock to New Environments: James O. Grandstaff, for publication in Proc. United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success, New York, 1949.

20. Fertility and Reproduction in Sheep in Relation to Breeding and Environment:
James O. Grandstaff, presented at International Symposium on High Altitude Biology held at Lima, Peru, South America, November 23-30, 1949.

21. Genetic and Environmental Factors affecting Staple Length in Navajo and Navajo Crossbred Weanling Lambs:
George M. Sidwell, James O. Grandstaff and Donald A. Price, Journal of Animal Science, February 1951.

22. Lamb Production of Navajo Ewes Bred to Columbia and Romney Rams, and Navajo Crossbred Ewes Bred to Lincoln and Cotswold Rams:
Donald A. Price, James O. Grandstaff and George M. Sidwell, Journal of Animal Science, February 1951.

23. Genetic and Environmental Factors Affecting Type and Condition in Navajo and Navajo Crossbred Weanling Lambs:
George M. Sidwell, Donald A. Price and James O. Grandstaff, Journal of Animal Science, May 1951.

24. Effects of Some Genetic and Environmental Factors on Yearling Traits of Navajo and Navajo Crossbred Ewes:
Donald A. Price, George M. Sidwell and James O. Grandstaff, Journal of Animal Science, November 1953.

SUMMARY OF PRECIPITATION

	Fort Wingate				El Morro		
	Average 1864-1911	Average 1938-1952	1953	1954	Normal	1953	1954
January	.96	.98	.20	.64	.93	.63	.43
February	1.42	.61	.67	.41	.84	.30	.27
March	1.02	.87	.65	3.85	1.18	1.40	1.61
April	.98	.66	.62	.41	.60	1.01	Tr.
May	.58	.58	.14	1.55	.41	.30	1.32
June	.69	.54	.71	.23	.53	.15	.60
July	2.34	1.61	2.42	4.17	1.80	2.51	2.28
August	2.31	2.21	.73	.96	2.76	1.52	2.82
September	1.37	1.27	.00	1.74	1.46	.00	3.05
October	1.05	1.05	1.16	.69	1.01	.53	.65
November	.76	.71	.78	.12	.52	.56	.11
December	.97	1.02	1.02	.49	1.03	.95	.45
ANNUAL	14.45	12.11	9.10	15.26	13.07	9.86	13.59

The above table summarizes the precipitation at Fort Wingate and El Morro, New Mexico. The El Morro data is presented because the ewes and lambs are grazed on the El Morro range for a large part of the year and because there are sometimes appreciable differences in the amounts of precipitation between the two locations. Data at Fort Wingate from 1938 to the present have been compiled from Station records: all other data have been secured from U. S. Weather Bureau reports.

WEATHER CONDITIONS

1953

On a statewide basis, 1953 was the fifth driest year since 1892, exceeding by only 0.33 inch the driest year on record. At Fort Wingate, 1953 was the second driest year since 1938. Precipitation for the year totaled 9.10 inches. This amount is 63.0 percent of the 47-year average (1864-1911), or 75.1 percent of the 1938-1952 average. At El Morro, the 9.86 inches of precipitation amounted to 75.4 percent of normal. During the growing season (May through September) Fort Wingate and El Morro received 6.21 and 6.96 inches of precipitation, respectively. This was approximately 64.4 percent of the more recent normal for both localities.

September and January were the two driest months of the year, and were also the driest January and September on record. July was the only month of the year that received more than the normal amount of precipitation.

1954

Despite above average amounts of precipitation at both Fort Wingate and El Morro for the year, 1954 can be characterized as a warm and relatively dry year. Temperatures for the year were above normal for most of the year, with only March and August being below average, but by less than one half degree. High winds prevailed during the late winter and spring months, and several severe storms occurred in May and July.

The period from March through September presented months that were alternately above and below average in precipitation. The remainder of the year was considerably below average. Many of the rain storms left relatively large amounts of precipitation, but were preceded and followed by hot, dry, windy weather which caused much of the moisture to be lost by rapid run off and evaporation.

In July, two storms within less than a week left 1.07 and 1.06 inches of rain, respectively. Most of this water was lost through runoff, but many of the stock tanks were filled.

SUMMARY OF OPERATIONS

1953

During the early months of the year, additional breeding ewes of "average" reservation quality were secured to complete the flock of 400 needed to establish a new sheep improvement experiment. This experiment was part of the plan-of-work agreed upon by the members of the wool conference held at the Laboratory on September 16 - 17, 1952.

Sampling of fleeces and scoring various physical characteristics of all newly acquired "average" reservation ewes and the yearling ewes and yearling and mature rams of the Laboratory flocks was accomplished April 13 to 15, inclusive. Shearing of all sheep took place the last week of April. Lambing began May 1, 1953 and lasted until June 15. Mr. T. D. Watkins arrived from the Agricultural Research Center, Beltsville, Maryland, the first of June to run the small fleece sample determinations for estimating clean fleece weight.

The late winter, spring, and early summer of 1953 were very dry, with below average temperatures. New grass did not begin to grow until after the rains in July. Since the Fort Wingate range had not been used during the two previous years, there was sufficient old forage on the ground to carry the flocks until mid-July when new grass became available. By the middle of J une, However, the situation was beginning to look desperate.

In early June, it was learned that the U. S. Public Health Service had turned over to the State of New Mexico their hospital located at Fort Stanton, New Mexico, and that approximately 26,000 acres of grazing land, formerly property of the hospital, had been declared surplus. The Laboratory attempted to obtain a temporary grazing lease on this land as an emergency measure to secure feed for the sheep that were then barely subsisting on ranges heavily hit by the drought. The Fort Stanton property is highly desirable grazing land, however, and a number of divergent interests immediately attempted to obtain the land for their own use. The matter rapidly became a "hot" political issue, and the Laboratory withdrew its request for the lease. Luckily, the rains began early in July and we were able to move the sheep to El Morro range about the middle of the month.

During the latter part of the summer, water became scarce in the surface tanks, and it was anticipated that it would be necessary to truck water to the sheep. However, our camp tender, Mr. Fred Deschene, dug out several seeps, piping the water into troughs, thereby obtaining enough water to supply the sheep.

Weanling data on the lambs were obtained the first week of September, and both the ewes and the lambs were culled the second week of October. Semen testing was completed during the first half of November and the Laboratory developed ewes were returned to Fort Wingate for weighing and branding on December first. The ewes obtained from the Navajo reservation were left on the El Morro range where they were divided at random into four groups of equal numbers and weighed and branded. The ewes and rams were herded separately on the range during the day, and were cut into their respective breeding lots each evening. Breeding, both at Fort Wingate and El Morro, occurred from December 4, 1953 through January 5, 1954.

1954

Upon completion of breeding on January 5, 1954, all sheep at Fort Wingate were returned to El Morro, where they remained until early April when all sheep were brought back to Fort Wingate for scoring and sampling.

Scoring and sampling were accomplished April 14 to 16, inclusive, and shearing occurred from April 20 through 23, inclusive. Lambing began April 26 and ended May 31. As lambing progressed, Navajo and Navajo crossbred ewes with lambs were returned to El Morro range, while the "average" reservation ewes and lambs were moved to the Fort Wingate range. Since the reservation ewes were in poorer condition than the other ewes and were showing markedly less mothering ability, it was felt the long haul to El Morro range would have caused a considerable number of these lambs to have been weaned and thus lost. They were moved to El Morro range and mixed with the rest of the herd in July, when they were better able to withstand the moving.

Bluetongue, a newly recognized disease of sheep in the United States, was first identified in flocks adjacent to the Laboratory flocks in the summer of 1954. All Laboratory sheep were vaccinated as soon as the newly developed vaccine became available, and they will continue to be vaccinated annually until such time as the disease is considered eradicated. No losses due to Bluetongue have occurred in the Laboratory flocks.

In June, 47 yearling Targhee ewes were obtained from private breeders in Idaho and Montana. In November, 10 yearling and 45 mature Targhee ewes and 10 Targhee rams were obtained from the U. S. Sheep Experiment Station, Dubois, Idaho. These sheep were acquired to start a line of purebred Targhee sheep for testing purposes.

Weaning of the lambs and collection of weanling data was completed the first week in September, and the ewes and lambs were culled October 11 to 15, inclusive. Semen testing occupied the first two weeks of November, and breeding, which followed the same pattern as in 1953, lasted from December 6, 1954 to January 7, 1955.

OUTLINE OF BREEDING PROGRAM

Type of Breeding and Group Number	Breeding of Rams	Breeding of Ewes	Number of Ewes Breeding Seasons 1952-3	1953-4
Navajo				
1	N	N	105	124
Coarsewool				
8	$C_2 \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	K x N	60	46
9	K x N	$C_2 \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	38	29
10	$R_1 \times N$	$L \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	68	55
11	$L \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	$R_1 \times N$	30	28
16	$(K \times N) \times [C_2 \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}]$	$[L \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}] \times (R \times N)$	102	185
Finewool				
12	T	$\begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	58	40
13*	$T \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	$T \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}$	45	79

OUTLINE OF BREEDING PROGRAM, CONTINUED

Type of Breeding and Group Number	Breeding of Rams	Breeding of Ewes	Number of Ewes Breeding Seasons 1952-3	1953-4
Reservation				
20	Res	Res	-	89
21	R_2	Res	-	90
22	T	Res	-	87
23	W	Res	-	89
Targhee				
25	T	T	-	-
Totals			506	941

* Group 13 contains a few ewes and rams that have inheritance from Rambouillet, Debouillet, and Merino sires that were used in 1948, 1949 and 1950. See summary of breeding program (next page) and Annual Reports 1949 - 1951, inclusive.

Code of Symbols for Breeds

C_1	Corriedale	R_1	Romney
C_2	Cotswold	R_2	Rambouillet
K	Columbia	Res	Reservation
L	Lincoln	T	Targhee
N	Navajo	W	Weaving Wool (Progeny from Group 16 matings)

SUMMARY OF BREEDING PROGRAM

1952 - 1953 Season

The breeding flock for the 1952-1953 season was reduced to 506 ewes in accordance with the plan of work developed at the wool conference held at the Laboratory in September of 1952. (See Sixteenth Annual Report, December 31, 1952). This plan of work called for the breeding of approximately 100 Navajo ewes, 300 Coarsewool ewes and 100 Finewool (Targhee crossbred) ewes. The remaining sound ewes were traded to individual Navajos for average Navajo Reservation type ewes during the fall and winter of 1952-1953. Since many of the Reservation ewes acquired through trading were not obtained until after the breeding season, and since many were ewe lambs not of breeding age, the Reservation ewes were not bred until the 1953-1954 season.

In February, 1953, it was discovered that 11 ewes in group 1, one ewe in group 9, and 3 ewes each in groups 11, 16 and 13 had been accidently bred prior to the regular breeding season, Consequently, the number of ewes listed below for each of these groups is the number originally assigned to the group minus the number of ewes which were later found to have been bred prematurely.

The various breeding groups were associated with the research line projects as follows:

Breeding Groups	No. of Matings	Research Project No.
1	94	1
8, 9, 10, 11, 16	291	2
12, 13	100	3

The number of Navajo ewes was reduced in accordance with the new plan of work.

Groups 6 and 7, which were discontinued in 1950, involved the matings of Lincoln and Cotswold rams, respectively, to ewes having an inheritance of 1/2 Navajo, 1/4 Romney and 1/4 Corriedale.

In group 8, F_1 Columbia x Navajo ewes were mated to Cotswold cross rams originating from group 7. The matings in group 9 are the reciprocal of those in group 8.

In group 10, Lincoln cross ewes originating from group 6 were mated to F_1 Romney x Navajo rams. The matings in group 11 are the reciprocal of those in group 10.

The ewes and rams in groups 16 and 17 were the progeny of matings in groups 8 and 9, and 10 and 11, respectively. Group 17 was discontinued in 1952 due to small numbers and the change in the breeding plans. Because of the similarity in breeding, the remaining ewes of group 17 were combined with those in group 16. In the future, the progeny from groups 8, 9, 10 and 11 will go into group 16.

Group 12 matings consisted of Targhee rams mated to crossbred ewes carrying an inheritance of 1/2 Navajo, 1/4 Romney, and 1/4 Corriedale.

Group 13 is comprised chiefly of matings between progeny from group 12, but it also contains a few ewes and rams that have inheritance from Rambouillet, Debouillet and Merino sires that were used in 1948, 1949, and 1950. During the period 1948 - 1952, breeding groups 14, 15, T-14, and T-15 were initiated and discontinued. Only a few progeny from each of these groups were saved or survived to breeding age. Due to small numbers, similarity of breeding and association with the same project, these few progeny from each of the breeding groups 14, 15, T-14, and T-15 were combined with group 13. The matings in these four groups were as follows:

(a) Groups 13 and 14 for the years 1948 and 1949 consisted of crossbred ewes having an inheritance of 1/2 Navajo, 1/4 Romney and 1/4 Corriedale mated to Merino and Debouillet rams, respectively.

(b) Group 15 for 1949 and 1950 consisted of Rambouillet rams mated to Navajo ewes.

(c) Group 13 in 1950 consisted of F_1 Rambouillet x Navajo rams mated to Targhee, Debouillet, and Merino crossbred ewes.

(d) Groups T-14 and T-15 in 1951 were made up of Targhee rams mated to Columbia x Navajo and Romney x Navajo ewes, respectively.

1953 - 1954 Season

The breeding flock for the 1953 - 1954 season was increased to 941 ewes by the addition of the Reservation ewes (groups 20, 21, 22 and 23) and by the natural increases in groups 1, 13 and 16. Groups 8, 9, 10, 11 and 12 continued to decline in numbers as replacement ewes for these groups are no longer being produced.

Summary of Breeding Program, continued.

The various breeding groups were associated with the research line projects as follows:

Breeding Groups	No. of Matings	Research Project No.
1	124	1
8, 9, 10, 11, 16	343	2
23	89	2
12, 13	119	3
20, 21, 22	266	3

Group 1 full blood Navajo ewes were allowed to exceed, by 24, the recommended number of 100 in order to partially offset the losses in numbers in other breeding groups, and to study the production of aged Navajo ewes.

Groups 8, 9, 10 and 11 declined in numbers from 1952 due to necessary culling of aged and unsound ewes. Replacement ewes for these breeding groups are no longer being produced.

Group 16 increased in numbers as progeny from groups 8, 9, 10 and 11, as well as those from 16, went into this breeding group.

Group 12 declined in numbers in 1953 due to necessary culling of aged and unsound ewes. Replacement ewes for this group are no longer being produced.

Group 13 increased in numbers as progeny from group 12, as well as 13, continued to be added to this breeding group.

Groups 20, 21, 22 and 23 are the Reservation ewes obtained in trades with individual Navajos, and mated to Reservation, Tribal Rambouillet, Targhee, and Fort Wingate Coarsewool (weaving wool) rams, respectively. Approximately 420 Reservation ewes and 11 Reservation rams were obtained through trading between November, 1952 and April, 1953. There were considerable death losses during the winter and late spring, however, and by late summer of 1953 only about 360 remained. These were divided at random by age between the four breeding groups by using a table of random numbers (Snedecor, 1948). By breeding time in December a few more had died, as can be seen in the table.

Summary of Breeding Program, concluded.

The four groups are range bred with 10 rams used per 100 ewes. The large number of rams are used in order to secure randomization of breeding.

Group 20 Reservation rams were obtained through trading with individual Navajos, and are of the same type as the ewes. All culling and selection within this group will be made at random so that, in so far as possible, there will be no genetic gain or loss.

Group 21 rams are high grade Rambouillet rams that are rented from the Navajo Tribal Ram Pasture Enterprise. These rams have been purchased by the Navajo Tribe from private breeders, and have met the New Mexico Experiment Station requirements for type, uniformity, fineness of fiber and staple length.

Group 22 rams are purebred Targhees that are purchased from the U. S. Sheep Experiment Station, Dubois, Idaho, or from private breeders.

Group 23 rams are the coarsewool or weaving wool rams that have been developed at the Laboratory. They are the progeny from group 16 matings.

MEASUREMENT OF BODY WEIGHTS, SCORES, FLEECE CHARACTERISTICS AND SELECTION PROCEDURE

1953

The lambs were born in May at the Laboratory headquarters. As the lambs became old enough, the ewes and lambs were moved out to the nearby Fort Wingate range. They were moved to the El Morro range in July, after the rains began. The lambs were weaned on September 1 and 2 at approximately 120 days of age. At weaning time, each lamb was weighed individually and the weight recorded to the nearest pound. Face covering, type, condition, and outercoat scores were taken by a committee of three men working independently. Color score, degree of horn development, and any abnormality of the jaw were also recorded. Small fleece samples were collected from the middle of the left side and thigh of each lamb at weaning time. From these samples, staple length was measured to the nearest .1 cm. and the percentage of kemp and other medullated fibers was recorded. These samples were then cross-sectioned to determine fiber diameter, also. The staple length measurement represented a constant age of 84 days since a small area was clipped close to the skin when the average age of the lambs was one month and the sample was taken from this area at weaning time.

Culling of the weanling lambs was done in October. The lambs were sorted by sex into their respective breeding pens to facilitate the work of selection. The lambs in each pen were considered individually for all traits evaluated at weaning time. The degree of selection practiced on each pen of lambs depended upon the individual merit of the lambs and the quality and uniformity of the pen of lambs as a group.

The fleeces of yearling ewes and rams and mature breeding rams were sampled a few days previous to shearing, for the evaluation of staple length, grade, percentages of kemp and other medullated fibers, and clean yield. Staple length was measured to the nearest .1 cm. at the side, while average fiber diameter and frequency of kemp and other medullated fibers were measured and recorded for both side and thigh positions. The clean yield was determined from a large sample of wool taken at the side and placed in an airtight can until it was scoured at a later date. At the same time as the sampling, each ewe and ram is individually scored by a committee of three for face covering and degree of outercoat fibers. Color of face and legs, horn development, and jaw formation are also recorded. Body weight and type and condition scores are recorded in June.

At shearing time, the weight of each fleece was recorded to the nearest .05 pound. The grease and clean fleece weights were adjusted to a constant age of 365 days, and the clean fleece weights to standard conditions of 12 percent moisture.

1954

The lambs were born in May at the Laboratory headquarters. As the lambs became old enough, the reservation ewes and lambs (groups 20, 21, 22, and 23) were moved out to the nearby Fort Wingate range. All other ewes and lambs were trucked to the El Morro range. In July, the reservation ewes and lambs were trucked to El Morro and mixed with the rest of the flock. The lambs were weaned August 31 and culled in October. All weaning and culling procedures were the same in 1954 as in 1953.

In addition to the usual data collected a few days before shearing, each yearling ewe and ram and mature ram was individually weighed to the nearest pound. Density of the fleece was measured by use of the Neale Density Meter. All data collected on the yearling sheep were also collected for the first time on the Reservation ewes and rams, in 1954. This data could not be collected in 1953 due to the unknown ages and shearing dates of the Reservation sheep.

RESEARCH PROJECT 1

IMPROVEMENT OF NAVAJO SHEEP BY LINEBREEDING AND SELECTION IN THE NAVAJO STRAIN

The objective of this project is the improvement of the Navajo strain of sheep in wool production and mutton conformation. This strain of sheep have greatest value as a source of inheritance for hardiness and adaptability to semi-arid areas, high fertility and mothering ability. Improvement in the quality and quantity of the fleece as well as improvement in mutton conformation will increase their usefulness for crossbreeding with improved breeds.

Data on the characteristics and production of the Navajo ewes and rams, and the traits of their weanling and yearling progeny are summarized in this section.

The data on weanling lambs has been adjusted to a constant age and for differences due to type of birth and rearing and for age of dam.

CHARACTERISTICS OF NAVAJO BREEDING RAMS

Number of rams used, age of the rams at lambing, and fleece characteristics of the Navajo rams mated to Navajo ewes in the years 1947 through 1954 are summarized in the following table. The data were taken on all rams at yearling age. The rams used have been selected primarily for quality and quantity of wool with some emphasis placed on body weight, type, condition, and color of face and legs. Rams used in 1953 and 1954 averaged less grease fleece and clean fleece weight, shorter staple length, and finer fleeces than those used in prior years. Inasmuch as most of these rams were produced during the drought years of 1950 and 1951, some of this reduction is probably due to environmental factors. There is also some evidence to indicate that part of this reduction is the result of selecting for rams having fleeces that are free, or nearly free, of outercoat fibers.

Since it is not known how severely inbreeding might affect the Navajo sheep, five rams rather than a smaller number are now being used. Until the Navajo strain possesses more of the desirable characteristics both in fleece and body conformation, inbreeding will be held to a minimum as far as it is practical to do so.

CHARACTERISTICS OF NAVAJO BREEDING RAMS

Year	No. of Rams	Age at Lambing (years)	Fleece Weights as Yearlings		Yearling Fiber Traits at Side		
			Grease (lbs.)	Clean (lbs.)	Grade*	Staple Length (cms.)	Medullated Fibers (percent)
1947	3	3.0	6.98	4.93	50s	17.2	1.1
1948	4	3.0	7.56	5.02	48s	18.4	.0
1949	4	4.0	7.15	4.86	48s	17.8	.0
1950	4	2.8	6.93	4.39	48s	13.9	1.8
1951	5	2.8	7.01	4.11	50s	13.1	.0
1952	5	3.4	6.04	3.50	50s	11.9	.5
1947 - 1952	25	3.2	6.91	4.39	50s	15.1	.5
1953	5	3.6	5.81	3.67	54s	11.2	.6
1954	5	2.8	5.34	3.20	54s	9.4	.6
1947 - 1954	35	3.2	6.53	4.12	50s	13.7	.5

* Grade for 1953 and 1954 based on latest ASTM Standards, adopted June 1953.

CHARACTERISTICS OF NAVAJO BREEDING EWES

The following table summarizes the characteristics of the Navajo ewes bred to Navajo rams in the years 1947 through 1954, All traits except the 18 months body weight were measured at yearling age. As Navajo ewes are not presently being used in the crossbreeding program, more stringent culling can be exercised, and more progress from selection can be made. Since most of the traits in the table are greatly affected by many environmental factors, especially that due to years, no very good comparison between years can be made. There is some evidence that the incidence of kemp fibers is being reduced, and also that the trend is toward younger ewes in the breeding flock.

Year	No. of Ewes	Age at Lambing (years)	Body Wt. at 18 Months (lbs.)	Fleece Weights as Yearlings		Yearling Fiber Traits at Side			
				Grease (lbs.)	Clean (lbs.)	Grade*	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)
1947	116	5.7	96.7	4.60	3.18	58s	9.5	0.9	1.7
1948	115	7.4	99.4	5.34	3.68	58s	9.0	0.6	0.6
1949	133	5.0	101.1	5.51	3.64	58s	10.0	0.3	0.8
1950	140	5.1	102.8	5.68	3.69	58s	10.2	0.2	1.2
1951	156	4.9	98.2	5.15	3.08	56s	11.1	0.0	1.5
1952	173	4.8	97.7	5.22	2.91	58s	10.9	0.1	1.6
1953	105	5.3	98.2	5.23	3.11	58s	10.4	0.1	1.7
1954	124	4.9	97.3	5.21	3.19	58s	10.5	0.1	1.1
1947-1954	1062	5.3	99.0	5.25	3.30	58s	10.3	0.3	1.3

* Grade for 1953 and 1954 based on latest ASTM Standards, adopted June, 1953.

LAMB PRODUCTION OF NAVAJO MATINGS

Lamb production of Navajo ewes mated to Navajo rams for the years 1937 through 1954 is summarized in the following table. For the period 1937 through 1951, the percent of ewes lambing was based on the numbers of ewes bred, but beginning in 1952 it is based on the number of ewes bred and still present at lambing. In this way the percentage of ewes lambing is an indication of fertility that is not confounded by post breeding death losses. This percentage is affected by the fertility of both the rams and the ewes. The percent of lambs born of ewes lambing is based on all lambs born, dead or alive, of ewes actually having lambs. This value minus 100 gives the percent of ewes having twins. The percent of lambs weaned of live lambs born is a measure of lamb mortaility from birth to weaning. The percent of lambs weaned of ewes bred is a combination of the first three values plus any effect of ewe loss after breeding. The average weaning weight for the years 1937 through 1946 constitutes weights unadjusted for any of the measureable environmental effects, and represents a growth period of about 140 days. Beginning in 1947, the weights are adjusted to a constant age of 120 days and are corrected for type of birth and rearing of the lamb and age of the dam.

There were 105 Navajo ewes originally assigned to breeding pens for 1953, but eleven were later found to have been previously bred to range rams and were therefore not included when computing averages. Of the remaining 94 ewes, 93 survived to lambing time and 87 of these had lambs. Percent of ewes lambing, percent of lambs born of ewes lambing, and percent of lambs weaned of live lambs born were all above average in 1953, and combined, resulted in the highest percentage of lambs weaned of ewes bred since 1946 and the second highest on record. Average weaning weight was down in 1953 from 1952, but pounds of lamb per ewe bred was the best since 1948.

In 1954, only three Navajo lambs born alive failed to survive to weanling age, and the 97.6 percent lambs weaned of lambs born alive is the highest on record for this breeding group.

LAMB PRODUCTION OF NAVAJO MATINGS

Year	No. of Ewes Bred	Percent 1/ of Ewes Lambing	Percent of Lambs Born of Ewes Lambing	Percent of Lambs Weaned of Live Lambs Born	Percent of Lambs Weaned of Ewes Bred	Average Weaning Wt. in Pounds	Pounds of Lamb per Ewe Bred
1937-41	1745	88.3	125.2	92.5	97.3	57.0	55.4
1942-46	852	88.6	148.2	84.4	109.7	58.1	63.8
1947	116	84.5	153.1	92.0	117.8	60.5	71.9
1948	115	85.2	163.3	80.4	103.3	57.3	64.4
1949	133	85.0	138.1	80.0	93.2	56.4	52.6
1950	140	61.4	131.4	87.0	68.1	42.4	28.9
1951	156	88.5	108.7	32.9	31.4	32.6	10.2
1947-51	660	80.8	136.8	72.7	79.8	48.8	43.3
1952	173	82.6	129.6	95.6	99.4	59.5	59.1
1953	105	93.5	137.9	93.3	119.1	52.6	62.7
1954	124	88.9	125.0	97.6	100.0	52.2	51.7

1/ Percent of ewes lambing of ewes bred for years 1937-1951, but percent of ewes lambing of ewes bred and present at lambing for years 1952-1954.

FACE AND BODY SCORES OF NAVAJO WEANLING LAMBS

The face and body scores of the Navajo weanling lambs from 1947 to 1954 are summarized in the following table. These scores were not taken prior to 1947.

The Navajo weanling lambs are characterized by open faces, clean legs, and poor body type, with a tendency to fatten rather slowly, especially with regard to external fat. The ewe lambs have been consistently better, with regard to type and condition scores, than the ram lambs.

It is doubtful that any trend can be shown in these data in this table since the committees doing the scoring have not been the same from year to year and scoring standards change with different committees. Yearly environmental differences can also influence the type and condition scores as shown by the relatively poor scores taken in 1950 and 1951. This is especially noticeable in the ewe lamb scores.

	RAM LAMBS				EWE LAMBS			
Year	No.of Lambs	Face Covering (score)	Type (score)	Condition (score)	No.of Lambs	Face Covering (score)	Type (score)	Condition (score)
1947	55	2.71	3.50	3.61	82	2.72	3.19	3.15
1948	71	2.83	3.10	2.88	61	2.76	3.04	2.73
1949	66	2.64	3.09	3.00	58	2.65	3.22	2.92
1950	54	2.44	3.36	4.38	40	2.33	3.23	4.02
1951	21	2.43	3.49	3.53	28	2.52	3.49	3.34
1952	90	2.10	3.68	3.74	82	2.03	3.12	3.09
1953	64	2.64	3.09	3.44	48	2.48	3.06	3.26
1954	60	2.52	3.08	3.11	64	2.59	3.12	3.34
1947-54	481	2.53	3.30	3.44	463	2.51	3.16	3.18

FLEECE CHARACTERISTICS OF NAVAJO WEANLING LAMBS

Data on fleece characteristics of the Navajo weanling lambs for the years 1947 through 1954 are summarized in the following table. In 1947, staple length was measured at a constant age of 111 days; in 1951, it was adjusted to a constant age of 120 days; and in all other years, it was measured at 84 days of growth. These differences should be considered in comparing the means of the years given in this table.

Although rigid selection has been practiced against kemp and other medullated fibers, a small number of lambs are encountered each year with an appreciable number of these objectionable fibers. However, in 1953 and, especially, 1954, there were appreciably fewer lambs with medullated fibers than in most previous years.

Outercoat scores in 1953 and 1954 were considerably better than all prior years, and would seem to indicate that some progress is being achieved in eliminating this objectionable fiber from the Navajo fleeces. Fiber diameter appears to be greatly affected by yearly environmental differences. More work needs to be done to determine the causes of these yearly fluctuations in fiber diameter.

Year	No. of Lambs Weaned	Fiber Diameter (microns)	Grade a/	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)	Outer-coat (score) b/
1947	137	27.8	56s	4.7	0.0	0.4	-
1948	132	28.7	54s	3.4	.3	3.2	3.78
1949	124	29.2	54s	4.1	.2	2.1	3.18
1950	94	28.4	56s	3.3	.3	4.3	3.36
1951	49	25.0	60s	4.2	.0	3.5	3.27
1952	172	29.6	54s	3.6	.7	6.1	3.51
1953	112	31.1	50s	3.4	.0	2.4	2.14
1954	124	25.9	58s	3.6	.9	0.9	2.81
1947-54	944	28.5	56s	3.8	0.3	2.9	3.17

a/ Grade for all years converted to latest ASTM Standards, adopted June, 1953.

b/ Scores for outercoat not taken prior to 1948.

SELECTION PRACTICED ON NAVAJO WEANLING LAMBS

The percentages of Navajo lambs saved, by sex, the selection differentials for most of the economically important traits considered at weaning time, the relative emphasis placed on each trait at culling time, and the expected genetic gains per generation are given in the following table. Heritability estimates for each trait are also included in this table.

Weanling selection differentials represent the average differences between the selected lambs and all lambs weaned, after corrections for environmental effects have been computed. Considerable selection is practiced on rams at later ages, but most of the effective selection of ewes occurs at weanling age. The relative emphasis placed on each trait was obtained by dividing the selection differential by the standard deviation for each trait.

Heritability estimates were obtained for Navajo and Navajo crossbred lambs for all traits except face covering score, color score, and outercoat score. The heritability estimate for face covering score obtained for range Targhee and Columbia lambs at the U. S. Sheep Experiment Station, Dubois, Idaho has been used to compute the expected genetic gain. Thus the estimate of expected genetic gain per generation for face covering score is accurate only to the extent that the Dubois heritability estimate is representative of the lambs at this station. Heritability estimates for color score and outercoat score have not been computed.

The expected genetic gain per generation for each sex was obtained by multiplying the selection differential times the heritability estimate. The overall expected genetic gain per generation from selection practiced at weanling ages on both sexes was computed by averaging the expected genetic gains of rams and ewes. As fewer ram lambs than ewe lambs are saved, more selection pressure can be exerted against the ram lambs, and it is noticed that most of the expected genetic gain per generation is obtained from the rams. These are relative gains, however, because not all lambs saved at weaning will be used for breeding and not all will produce offspring.

In 1953, 10 ram lambs and 27 ewe lambs were saved from totals of 69 and 48 weaned, respectively. In 1954, 11 ram lambs and 30 ewe lambs were saved from totals of 60 and 64 weaned, respectively. This represents a larger saving of ram lambs, both numerically and percentage wise, than occurred in 1952, but is smaller than in earlier years. Approximately the same percentages of ewe lambs were saved as in the last several years, but less than were saved prior to 1950. Considering the reduced size of the Navajo line and the fact that Navajo sheep are not currently being used in crossbreeding, however, these are relatively larger savings than have occurred in the past. This relatively larger number of lambs saved allows for additional culling at yearling age and allows for the replacement of older ewes with younger ones.

The negative selection differentials for staple length and fiber diameter represent selection for lambs with shorter and finer staple. This is a natural consequence of selecting against kemp and outercoat fibers and can be considered an improvement. For all other traits, positive signs indicate genetic gains, while negative signs indicate that the lambs saved were poorer than the average of all lambs in the group from which they were selected.

The greatest emphasis at culling time, for the ram lambs, was placed on outercoat score, condition score, and body weight in 1953, and on condition score, body type score and weight in 1954. For the ewe lambs, the greatest emphasis was placed on condition score, color score, and outercoat score in 1953, and on outercoat score, fiber diameter, and condition score in 1954. No very great expected genetic gains per generation are evident for any trait except weaning weight.

SELECTION PRACTICED ON NAVAJO WEANLING LAMBS

		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent saved
	HERITABILITY	21%	6%	30%	46%*	4%	11%	-	-	
1953										
RAMS:	Selection Differential	3.98	-.17	-.27	.11	.18	.36	.37	.76	15.63
	Relative Emphasis	.67	-.28	-.11	.23	.44	.69	.46	1.00	
	Expected Genetic Gain	.836	-.010	-.081	.051	.007	.040			
EWES:	Selection Differential	.41	-.11	-.36	.07	.08	.15	.29	.17	56.25
	Relative Emphasis	.08	-.20	-.18	.14	.19	.31	.29	.24	
	Expected Genetic Gain	.086	-.007	-.108	.032	.003	.016			
RAMS AND EWES:										
	Expected Genetic Gain per Generation	.461	-.008	-.094	.042	.005	.028			
1954										
RAMS:	Selection Differential	5.48	-.09	-.53	.03	.30	.47	.17	.19	18.33
	Relative Emphasis	.69	-.16	-.30	.05	.73	1.07	.17	.21	
	Expected Genetic Gain	1.151	-.005	-.159	.014	.012	.052			
EWES:	Selection Differential	1.44	-.06	.42	.04	.01	.10	.02	.51	46.88
	Relative Emphasis	.23	-.10	.27	.09	.02	.24	.02	.50	
	Expected Genetic Gain	.302	-.004	..126	.018	.000	.011			
RAMS AND EWES:										
	Expected Genetic Gain per Generation	.726	-.004	-.016	.016	.006	.032			

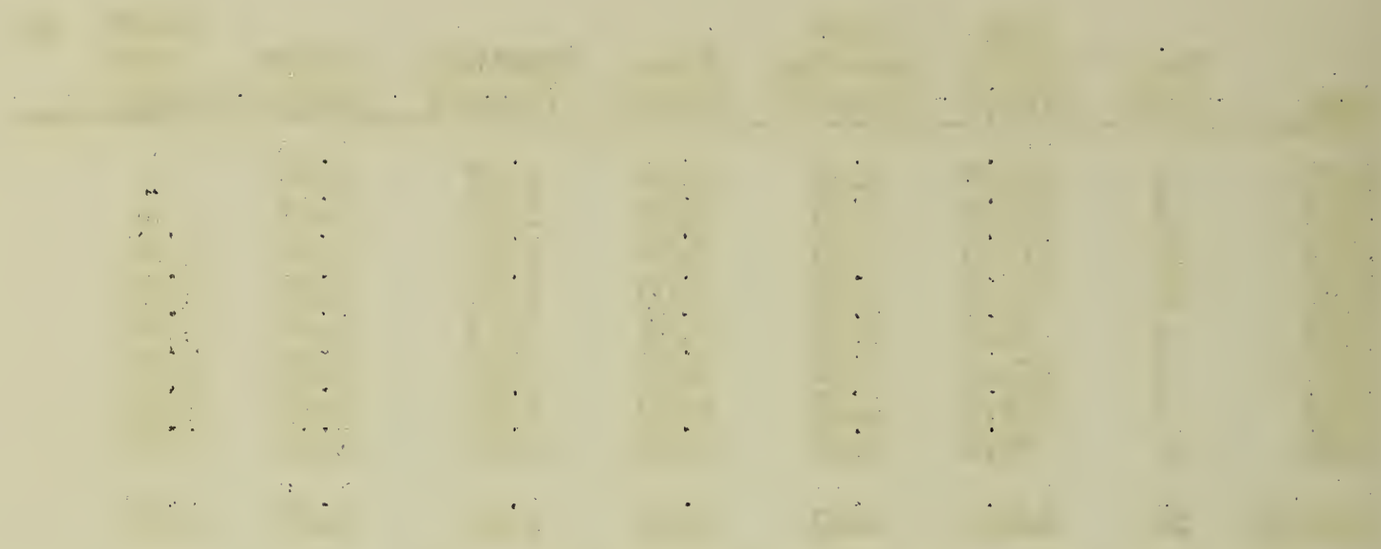
* Heritability estimate for face covering score as obtained for range Targhee and Columbia lambs at the U. S. Sheep Experiment Station, Dubois, Idaho.

BODY WEIGHTS AND SCORES OF NAVAJO YEARLING RAMS

Year	No.of Rams	Body Weight (lbs.)	Face Covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score) a/
1947	2	115.0	2.25	3.17	3.09	1.50	-
1948	6	115.2	2.23	3.20	2.96	1.17	-
1949	14	112.3	2.33	2.89	2.64	1.36	2.24
1950	10	103.5	2.60	3.00	2.97	1.50	2.07
1951	9	90.9	2.58	2.67	3.13	1.00	3.60
1952	2	101.0	1.94	3.06	3.44	1.00	2.00
1953	8	112.0	1.27	2.90	2.68	1.50	2.63
1954	10	95.8	1.60	3.65	2.98	1.10	1.48
1947-54	61	105.0	2.13	3.05	2.90	1.28	2.35

a/ Scores for outercoat not taken prior to 1949.

Body weight and condition scores in 1953 were the best since 1949, and were well above the 1947-1954 average. Type and outercoat scores for the same year were approximately average. In 1954, body weight and type and condition scores declined considerably from the 1953 high, but outercoat score was by far the best on record. Face covering score has been well above the average for the past three years. Selection against color of face and legs continues, but there are still a considerable number of animals each year that have some degree of color.



FLEECE CHARACTERISTICS OF NAVAJO YEARLING RAMS

The fleece characteristics of all Navajo yearling rams from 1947 through 1954 are summarized in the following table. The fleeces of all rams have been free of kemp fibers as far as this can be determined from laboratory tests. Selection against kemp, other medullated fibers, and coarse outercoat fibers has improved the quality of the fleeces, but at the same time it has reduced the effectiveness of selection for fleece weight and staple length.

		Fleece Weights		Fiber Traits at Side			
Year	No. of Rams	Grease (lbs.)	Clean (lbs.)	Fiber Diameter (microns)	Grade*	Staple Length (cms.)	Medullated Fibers (percent)
1947	2	7.18	4.70	33.6	46s	14.8	0.0
1948	6	6.65	3.88	32.0	48s	15.0	1.2
1949	14	6.43	4.30	28.8	54s	11.6	.1
1950	10	6.56	3.92	28.1	56s	12.6	.0
1951	9	5.82	3.32	30.0	54s	12.8	2.1
1952	2	5.39	3.07	29.1	54s	9.5	.0
1953	8	5.09	3.20	30.3	50s	10.4	.0
1954	10	3.95	2.72	23.6	62s	7.8	.0
1947-54	61	5.79	3.59	28.7	54s	11.5	0.5

* Grade for all years converted to latest ASTM Standards, adopted June, 1953.

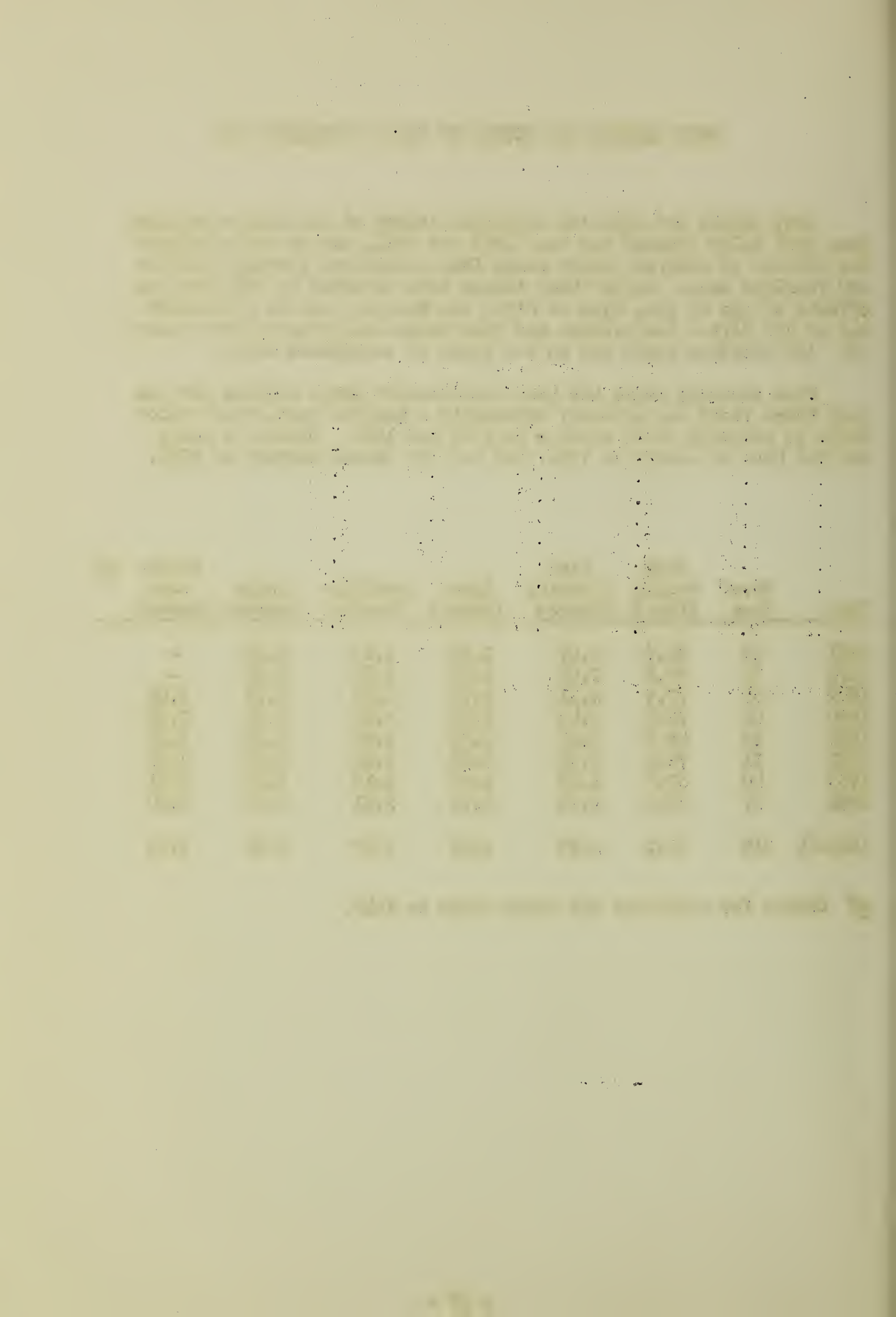
BODY WEIGHTS AND SCORES OF NAVAJO YEARLING EWES

Body weight and type and condition scores of the Navajo yearling ewes were below average for both 1953 and 1954, and no doubt reflect the effects of adverse winter range feed conditions between weanling and yearling ages. These three traits were adjusted in 1954 for the effects of age of dam, type of birth and rearing, and to a constant age of 400 days - the average age when these measurements were recorded. All previous years are on the basis of unadjusted data.

Face covering score has been consistently above average for the past three years and probably represents a genetic gain, while color score is slightly above average in 1953 and 1954. Outercoat score was the best on record in 1954, but was the second poorest in 1953.

Year	No.of Ewes	Body Weight (lbs.)	Face Covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score) a/
1947	39	84.6	2.07	3.29	3.13	2.46	-
1948	75	86.8	2.58	2.97	2.68	1.32	-
1949	55	77.9	2.31	2.74	2.49	1.72	3.08
1950	46	75.7	2.43	2.84	2.91	1.30	3.05
1951	26	46.6	2.51	3.35	3.20	1.88	3.38
1952	11	75.4	1.92	3.06	3.22	2.39	3.91
1953	40	67.6	1.65	3.08	3.13	1.58	3.61
1954	27	73.1	1.93	3.24	2.91	1.26	2.50
1947-54	319	76.2	2.25	3.02	2.87	1.64	3.18

a/ Scores for outercoat not taken prior to 1949.

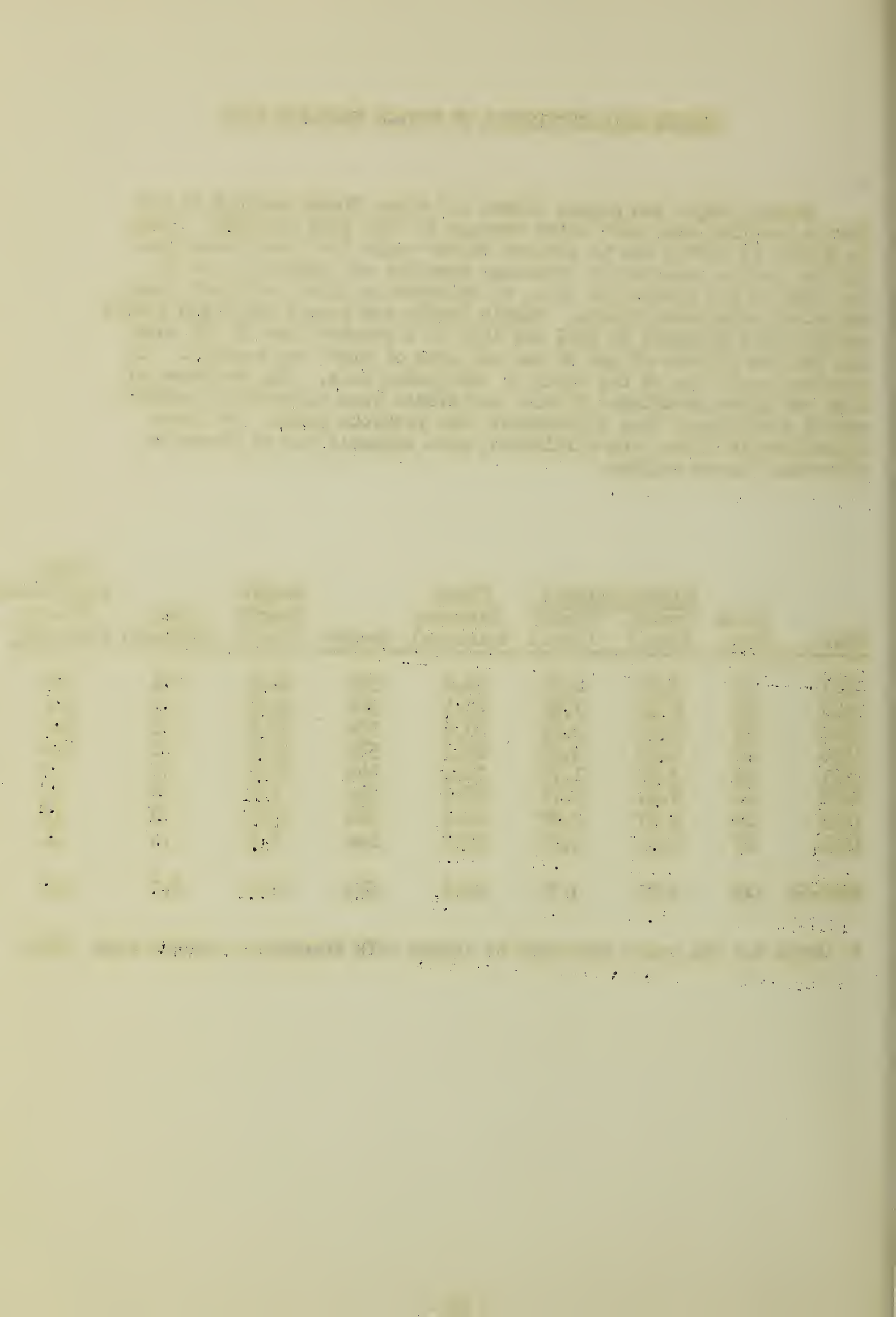


FLEECE CHARACTERISTICS OF NAVAJO YEARLING EWES

Staple length and grease fleece and clean fleece weights of the Navajo yearling ewes were below average in both 1953 and 1954. This, no doubt, is partly due to adverse winter range feed conditions during the months immediately preceding shearing and sampling, and it may also be the result, in part, of selection against outercoat, kemp, and other medullated fibers. Staple length and grease and clean fleece weights were adjusted in 1953 and 1954 to a constant age of 365 days and for the effects of age of dam and type of birth and rearing. All previous years are on the basis of unadjusted data. The incidence of kemp and other medullated fibers, two traits less affected by environmental conditions, show improvement over previous years. As these objectionable fibers are eliminated, more emphasis can be placed on improving fleece weights.

Year	No. of Ewes	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Grade*	Staple Length (cms.)	Kemp (percent)	Other Medullated Fibers (percent)
1947	39	5.14	4.00	31.6	50s	11.4	0.1	3.0
1948	75	6.19	3.82	28.1	56s	12.5	.2	1.1
1949	55	5.73	3.69	26.0	58s	10.5	.5	3.0
1950	46	6.38	3.38	26.1	58s	11.4	.1	1.6
1951	26	3.27	1.75	21.4	64s	10.2	.1	.9
1952	11	5.14	2.77	28.9	54s	9.1	.0	.7
1953	40	4.57	2.99	26.2	58s	10.6	.3	.8
1954	27	4.31	2.91	24.8	60s	8.8	.0	.1
1947-54	319	5.37	3.37	26.8	58s	11.0	0.2	1.6

* Grade for all years converted to latest ASTM Standards, adopted June, 1953.



IMPROVEMENT OF NAVAJO SHEEP BY CROSSBREEDING AND SELECTION FOR THE PRODUCTION OF WOOL SUITABLE FOR BOTH HAND AND COMMERCIAL METHODS OF MANUFACTURE.

The objective of this research project is the development of coarse-wooled strains of sheep that combine adaptability to south-western ranges with efficient production of good quality feeder lambs and wool of 46s, 48s and 50s grades. Selection emphasis is placed primarily on adaptability and longevity of the sheep, yield of wool and its suitability with respect to hand weaving and commercial manufacture, and the quantity and quality of lambs produced.

Information on the characteristics and production of the sheep used in project 2 are presented in this section.

CHARACTERISTICS OF COARSE WOOL, CROSSBRED BREEDING RAMS

Various characteristics of the breeding rams used in research project 2 are presented in the following table. Since breeding groups 2, 3, 6, and 7, which consisted of purebred rams mated to Navajo or Navajo crossbred ewes, were discontinued in 1951, the totals given for 1950 include only those rams used in breeding groups 8, 9, 10, 11, and 16. Data for years prior to 1950 are not presented because the matings consisted largely of purebred rams mated to Navajo or Navajo crossbred ewes. The breeding of the rams in each group is given in the outline of breeding program at the beginning of this report. Fleece characteristics considered are grade, staple length, uniformity, freedom from kemp and other medullated fibers, and yield of grease and clean wool.

The breeding rams used in the 1953 and 1954 seasons had body weights and clean fleece weights superior to the rams used in 1952, but not equal to the 1950 and 1951 averages for these traits. Grease fleece weights and staple lengths were approximately the same in 1953 and 1954 as they were in 1952, which was considerably less than in 1950 and 1951. The percentage of medullated fibers was reduced in 1953 and completely eliminated in 1954.

CHARACTERISTICS OF COARSEWOOL, CROSSBRED BREEDING RAMS

Year and Breeding Group No.	No. of Rams	Age of Rams at Lambing (years)	Body Weight at Breeding (lbs.)	Fleece Weights as Yearlings		Yearling Fiber Traits at Side		
				Grease (lbs.)	Clean (lbs.)	Grade*	Staple Length (cms.)	Med. Fibers (percent)
1950	15	2.4	178.9	10.48	6.97	48s	12.67	.04
1951	18	2.5	181.4	10.31	5.79	50s	12.77	.06
1952	16	2.9	165.9	8.92	4.73	50s	11.96	.15
1950-52	49	2.6	175.6	9.91	5.81	50s	12.47	.08
1953 Group								
8	2	4.5	205.5	9.85	5.93	48s	13.0	.52
9	2	3.5	187.0	9.02	4.28	56s	11.0	.00
10	3	3.7	176.3	8.93	5.00	54s	12.7	.00
11	1	5.0	199.0	11.45	7.20	46s	13.5	.00
16	4	2.2	148.8	7.50	4.41	50s	10.8	.00
Totals & Averages	12	3.4	175.7	8.83	5.02	50s	11.9	0.09
1954 Group								
8	2	4.5	182.5	9.35	4.64	48s	11.8	0.0
9	1	4.0	198.0	7.75	3.46	56s	10.8	0.0
10	2	5.0	191.0	9.00	5.16	54s	12.8	0.0
11	1	6.0	172.0	11.45	7.20	46s	13.5	0.0
16	7	2.6	154.7	8.55	5.05	50s	11.8	0.0
Totals & Averages	13	3.6	169.2	8.90	5.05	50s	12.0	0.0

* Grade for 1953-54 based on latest ASTM Standards, adopted June, 1953.

CHARACTERISTICS OF COARSEWOOL, CROSSBRED BREEDING EWES

Average age of the ewes at lambing, body weight at 18 months, and yearling fleece characteristics of the breeding ewes in research project 2 are summarized by their respective breeding groups in the following table. Since breeding groups 2, 3, 6, and 7, which consisted of purebred rams mated to Navajo or Navajo crossbred ewes, were discontinued in 1951, the totals given for 1950 include only those ewes assigned to breeding groups 8, 9, 10, 11, and 16. Data for prior years are not presented as they consisted largely of above mentioned types of matings. Average age at lambing has increased in groups 8, 9, 10 and 11 because young replacement ewes for these groups are no longer being produced.

Fleece grade appears to grow increasingly finer from 1950 to 1952, and then to level off with the 1952 grade maintained in 1953 and 1954. It has been noticed, however, that there are considerable yearly variations in grade that seem to reflect fluctuations in feed conditions. Since the fleece samples are taken in early April and are cross-sectioned proportionally about one-fourth the distance from the base of the lock, the fiber diameter determinations are representative of wool grown during the winter months when range feed conditions are low and variable. It is doubtful if this apparent increase in fineness represents a genetic change.

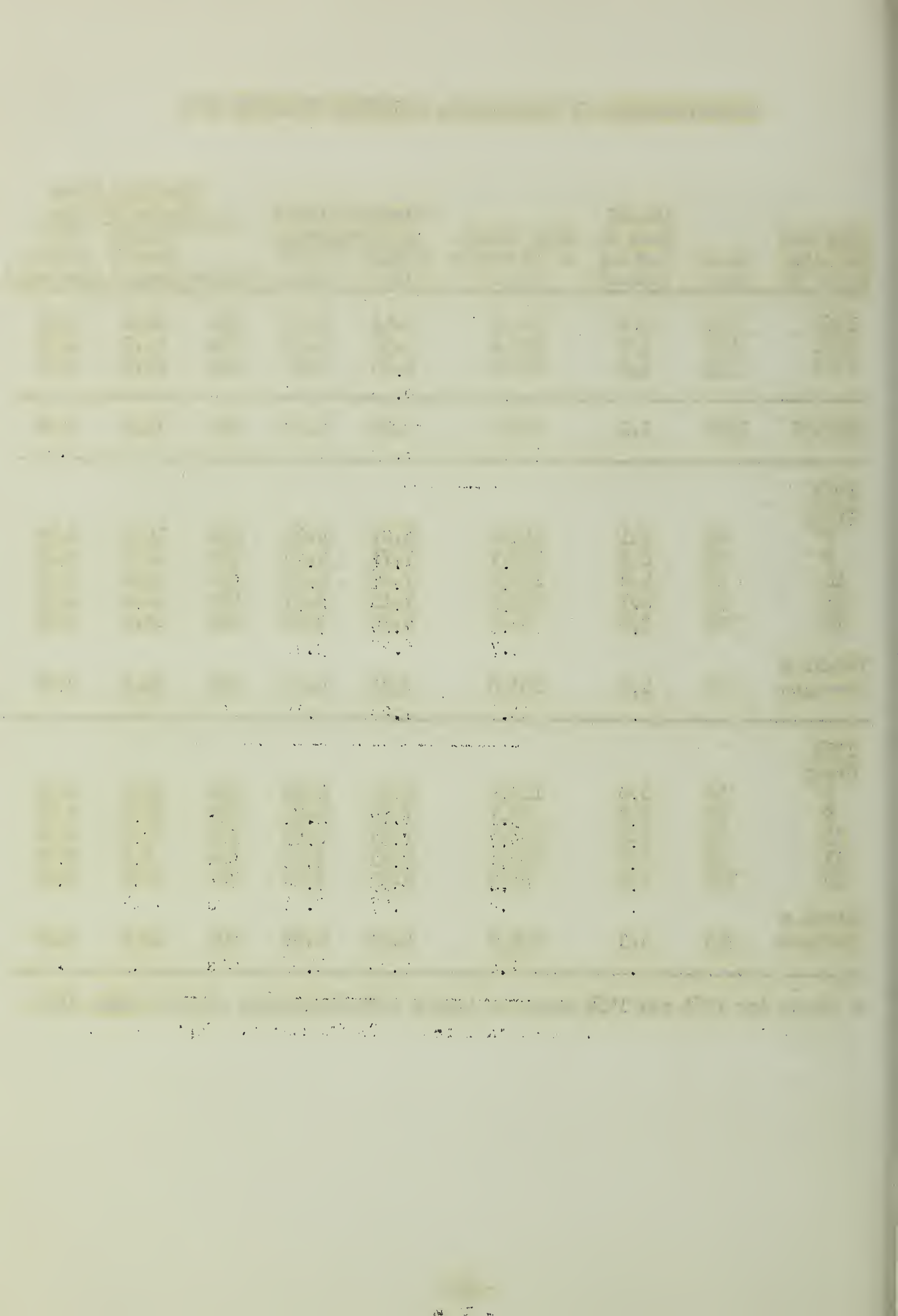
The percentage of medullated fibers at side has decreased steadily since 1950 and probably represents a genetic gain. Kemp fibers have amounted to less than 0.01 percent of total fibers for the past five years and are no longer reported. The percentages of kemp and other medullated fibers were slightly higher at the thigh position than at the side.

Clean fleece weights show improvement over 1952, but are not equal to prior years, while grease fleece weights and body weights at 18 months are more variable. Average staple length for all breeding groups has remained fairly constant over the past five years.

CHARACTERISTICS OF COARSEWOOL, CROSSBRED BREEDING EWES

Year and Breeding Group No.	No. of Ewes	Age of Ewes at Lambing (years)	Body Weight at 18 Months (lbs.)	Fleece Weights as Yearlings		Yearling Fiber Traits at Side		
				Grease (lbs.)	Clean (lbs.)	Grade*	Staple Length (cms.)	Med. Fibers (percent)
1950	501	2.7	114.9	7.43	4.51	56s	11.1	1.74
1951	612	3.2	109.4	7.58	4.29	58s	11.3	1.27
1952	553	3.6	102.0	6.83	3.27	60s	11.2	0.98
1950-52	1666	3.2	108.6	7.29	4.02	58s	11.2	1.32
1953 Group								
8	60	5.1	113.0	8.07	4.52	60s	10.7	0.99
9	38	4.6	103.9	7.71	4.56	58s	13.2	1.46
10	68	4.8	109.2	7.66	4.75	58s	11.6	0.65
11	30	4.7	103.0	7.15	3.94	58s	10.0	1.02
16	102	3.0	94.7	6.25	3.46	60s	11.0	0.34
Totals & Averages	298	4.2	103.8	7.23	4.16	60s	11.3	0.75
1954 Group								
8	46	6.0	113.1	8.12	4.54	60s	10.7	0.92
9	29	5.3	99.7	7.54	4.41	60s	12.8	1.23
10	55	5.8	109.1	7.55	4.73	58s	11.5	0.54
11	28	5.8	101.4	6.93	3.84	58s	9.9	0.96
16	185	3.0	96.8	5.97	3.71	60s	10.7	0.19
Totals & Averages	343	4.3	101.6	6.73	4.05	60s	10.9	0.49

* Grade for 1953 and 1954 based on latest ASTM Standards, adopted June, 1953.



LAMB PRODUCTION OF COARSEWOOL CROSSBRED MATINGS

Lamb production of the ewes in research project 2 is summarized by breeding groups for 1953 and 1954 in the following table. The lamb production is summarized for 1952 and by five year periods for 1937-41, 1942-46, and 1947-51. The bulk of the matings for the three 5-year periods consisted of purebred rams of several breeds mated to Navajo or first and second cross Navajo ewes. For this reason the 1937-51 data are not directly comparable with the data for the last three years.

The percent of ewes lambing was based on numbers of ewes bred for the years 1937-51, but beginning in 1952, it is based on the number of ewes bred and still present (surviving) at lambing time. The more recent method of computation gives an indication of fertility that is not confounded by post-breeding death losses. This percentage is affected by the fertility of both the rams and the ewes. Percent of lambs born of ewes lambing minus 100 gives the percentage of ewes having twin lambs. The percent of lambs weaned of live lambs born is a measure of lamb mortality. Average weaning weight and pounds of lamb per ewe bred for the years 1937-1946 are based on weights taken at about 140 days of age and unadjusted for any of the measurable environmental factors. Beginning in 1947 the weights are adjusted to a constant age of 120 days and are corrected for type of birth and rearing of the lamb and age of the dam.

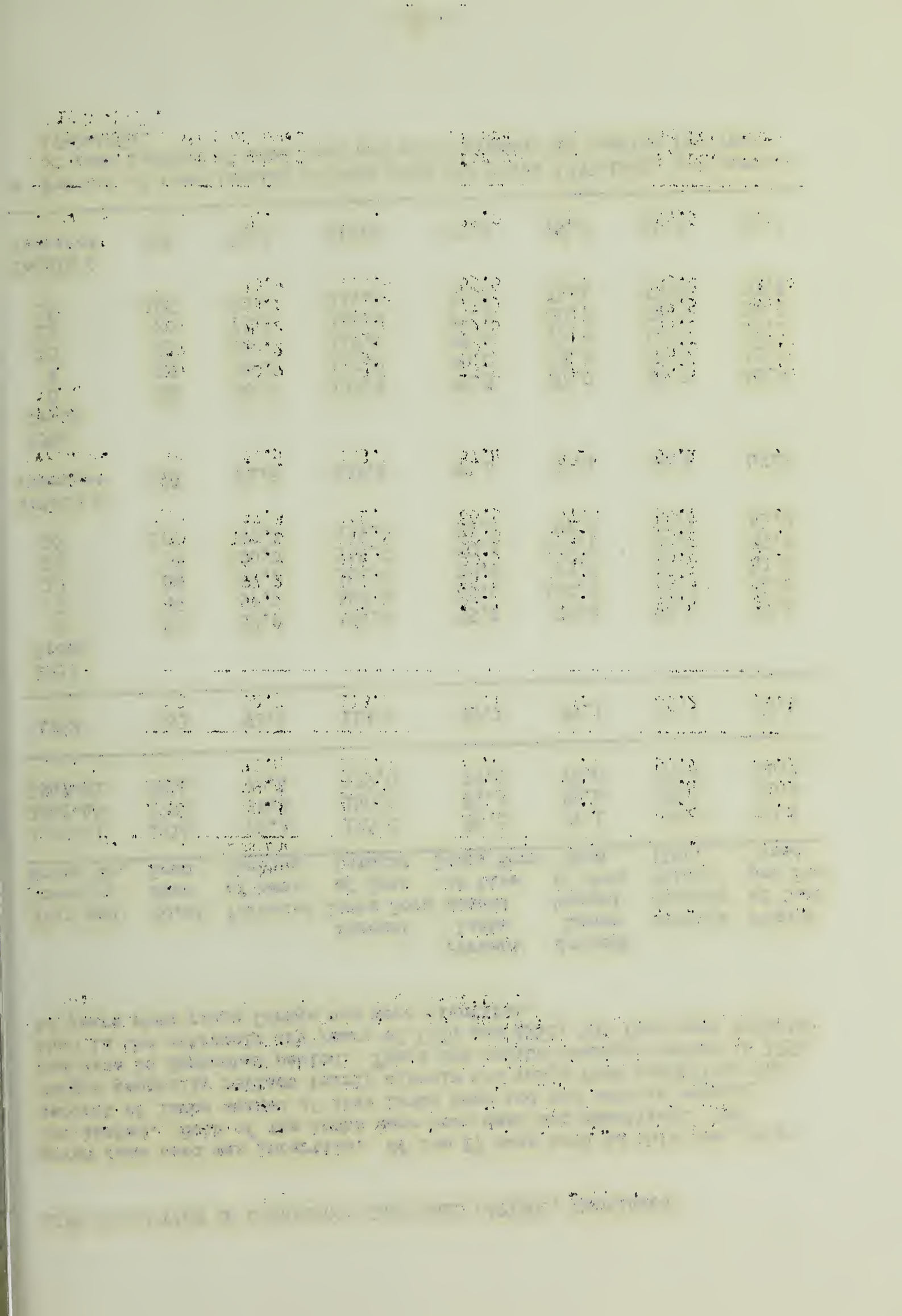
For 1953, one of the ewes in group 9, three in group 11, and three in group 16 were discovered to have been accidentally range bred prior to the regular breeding season and were, therefore, omitted when computing the various percentages. In addition, four ewes each in groups 8 and 10, one ewe in group 9, and six ewes in group 16 died or were missing between breeding and lambing times. In group 8, one of the two rams used was of low fertility. Of the 30 ewes to which he was mated, 6 lambed, 18 were range bred, 4 were dry and 2 died. In group 10, one of the three rams used proved to be completely sterile, as none of the 22 ewes to which he was mated lambed. The failure of these two rams to breed satisfactorily is responsible for the low percentage of ewes lambing, percent of lambs weaned of ewes bred, and pounds of lamb per ewe bred for groups 8 and 10. In other respects, 1953 was an average year for lamb production with none of the traits being exceptionally high or low. Average weaning weight was lower than any of the previous 5-year averages, but not as low as some of the individual years (1950 and 1951 in particular) that make up the five year averages.

For 1954, two ewes each in groups 8, 11, and 16 and three ewes each in groups 9 and 10 died or were missing between breeding and lambing times. Five dry ewes and two range bred ewes account for the low percentage of ewes lambing in group 11. In group 16, one of the

seven rams used was infertile. Of the 27 ewes bred to this ram, only two lambed. Both of the lambs were born dead and mummified. The percent of lambs weaned of live lambs born and the average weaning weight generally reflect fairly closely the range feed conditions for the June to September period. These two traits averaged better in 1954 than in the extremely dry years of 1950 and 1951, but they were inferior to years when range forage was more plentiful.

Year and Breeding Group No.	No.of Ewes Bred	Percent* of Ewes Lambing	Percent Lambs Born of Ewes Lambing	Percent Lambs Weaned of Live Lambs Born	Percent Lambs Weaned of Ewes Bred	Average Weaning Weight (lbs.)	Pounds of Lamb per Ewe Bred
1937-41	1216	88.3	126.0	88.8	97.1	59.9	58.2
1942-46	1794	79.8	140.6	81.3	89.4	59.4	53.1
1947-51	3864	79.4	129.0	76.2	76.6	57.9	44.3
1952	553	92.3	113.2	87.1	89.3	66.2	59.1
1953 Group							
8	60	58.9	154.5	85.7	70.0	54.4	38.1
9	38	97.2	142.9	85.4	110.8	58.3	64.6
10	68	60.9	141.0	90.9	73.5	56.8	41.8
11	30	100.0	118.5	90.3	103.7	55.8	57.9
16	102	97.8	124.2	86.5	97.0	55.7	54.0
Totals & Averages	298	81.5	133.8	87.4	88.3	56.1	49.6
1954 Group							
8	46	90.9	123.5	75.5	87.0	56.3	48.9
9	29	96.2	120.0	90.0	93.1	58.0	54.0
10	55	94.2	118.4	69.6	70.9	54.0	38.3
11	28	73.1	126.3	77.3	60.7	57.5	34.9
16	185	80.9	114.9	85.6	74.1	53.8	39.8
Totals & Averages	343	84.9	119.2	81.0	75.8	54.9	41.6

* Percent of ewes lambing of ewes bred for years 1937-1951, but percent of ewes lambing of ewes bred and still present at lambing for years 1952-1954.



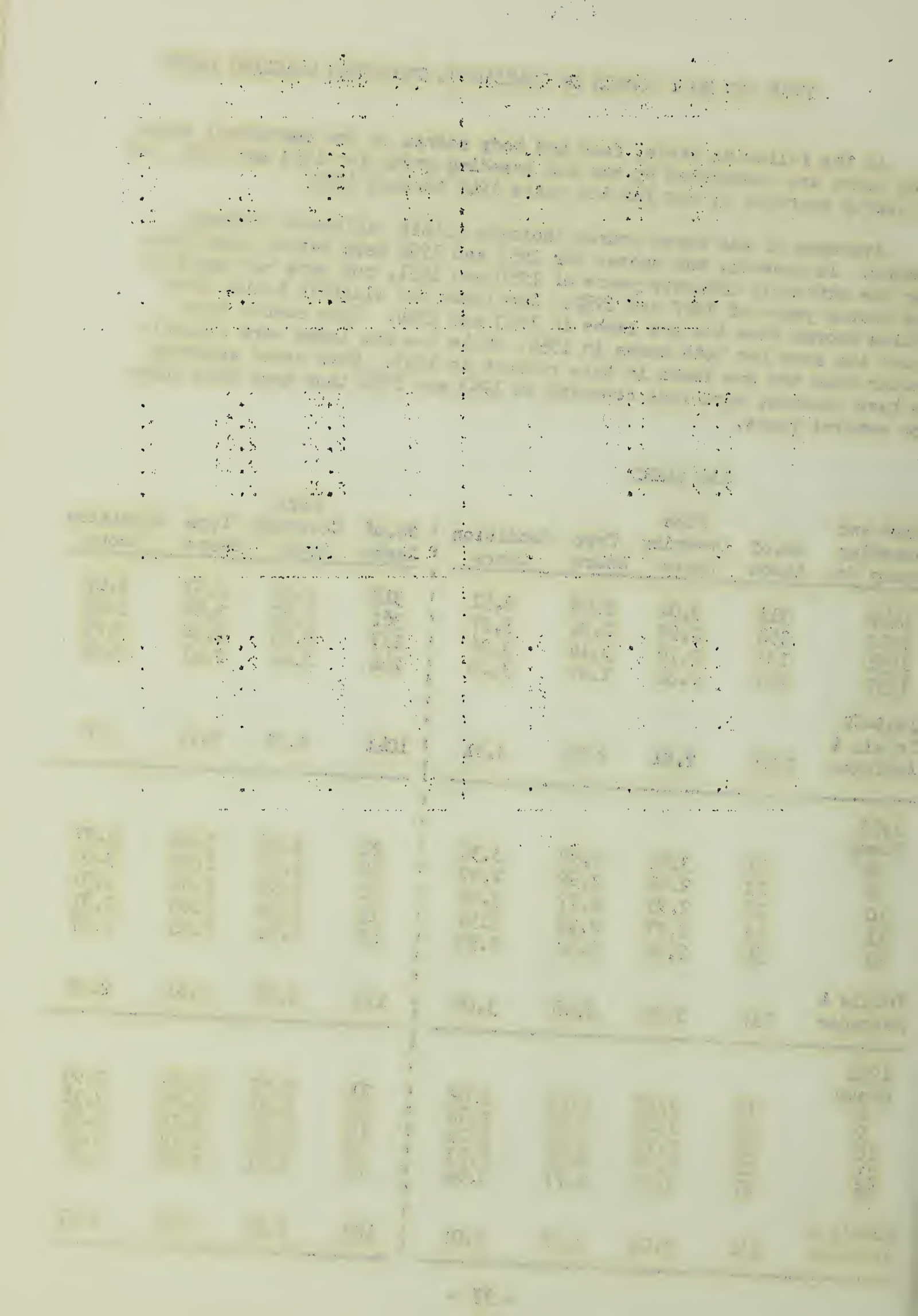
FACE AND BODY SCORES OF COARSEWOOL CROSSBRED WEANLING LAMBS

In the following table, face and body scores of the coarsewool weanling lambs are summarized by sex and breeding group for 1953 and 1954, and by yearly averages by sex for the years 1949 through 1952.

Averages of the three scores indicate little difference between groups. In general, the scores for 1953 and 1954 were better than those for the extremely droughty years of 1950 and 1951, but were not equal to the better years of 1949 and 1952. Ram lambs had slightly better condition scores than the ewe lambs in 1953 and 1954. Type scores were about the same for both sexes in 1954, while the ram lambs were slightly better than the ewe lambs in this respect in 1953. Both sexes appeared to have somewhat more face covering in 1953 and 1954 than they have shown for several years.

RAM LAMBS

Year and Breeding Group No.	No. of Lambs	Face Covering Score	Type Score	Condition Score	No. of Lambs	Face Covering Score	Type Score	Condition Score
1949	311	3.04	2.45	2.51	318	2.98	2.57	2.49
1950	358	2.99	2.94	3.97	362	2.85	2.88	3.85
1951	133	2.70	3.14	3.26	117	2.63	3.18	3.25
1952	249	2.34	2.81	3.40	244	2.24	2.41	2.59
1949-52 Totals & Averages	1051	2.81	2.79	3.31	1041	2.72	2.71	3.07
1953 Group								
8	21	3.24	2.92	3.36	21	3.05	2.80	2.97
9	23	2.61	2.59	2.97	18	2.67	2.88	3.00
10	28	2.95	2.77	3.09	22	2.50	2.86	3.01
11	13	2.97	2.52	2.91	15	2.82	2.68	2.81
16	54	2.92	2.62	2.99	42	2.84	2.80	2.97
Totals & Averages	139	2.92	2.68	3.06	118	2.78	2.81	2.96
1954 Group								
8	19	3.19	2.77	3.02	21	2.97	2.79	2.96
9	13	3.15	2.63	2.80	14	2.83	2.98	3.16
10	20	2.75	2.89	3.06	19	2.91	2.75	2.89
11	12	2.86	2.62	2.93	5	2.93	2.72	3.09
16	67	3.07	2.77	3.04	70	2.91	2.67	2.94
Totals & Averages	131	3.03	2.76	3.01	129	2.91	2.74	2.97

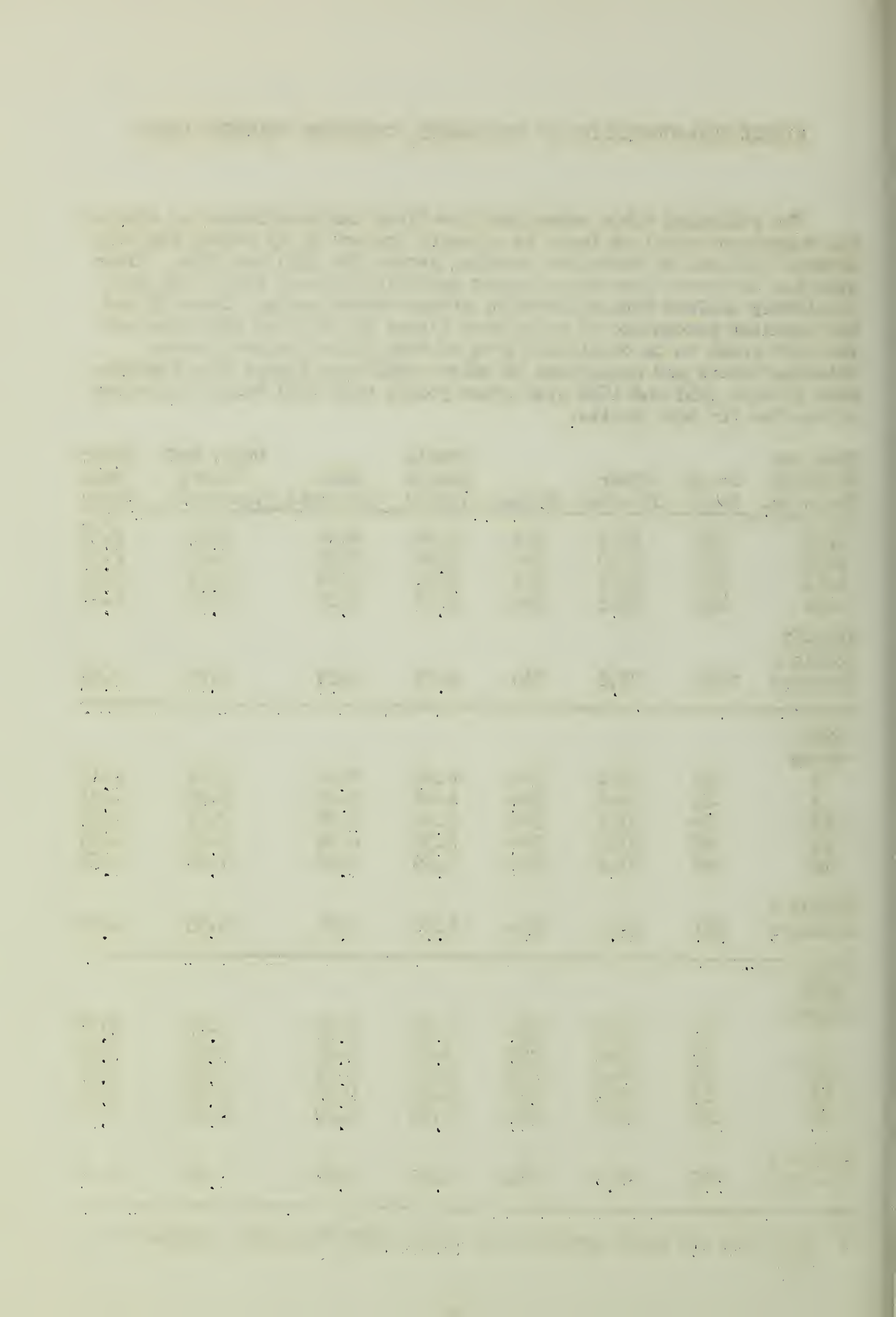


FLEECE CHARACTERISTICS OF COARSEWOOL, CROSSBRED WEANLING LAMBS

The following table summarizes the fiber characteristics at side of the coarsewool weanling lambs in research project 2, by years, for 1949 through 1952,and by years and breeding groups for 1953 and 1954. Fiber diameter and grade show the greatest variation between years, but are relatively uniform between breeding groups within years. Group 11 had the smallest percentage of medullated fibers in 1953 and 1954, and was the only group to be completely free of kemp fibers in both years. Outercoat score and percentage of other medullated fibers show improvement in both 1953 and 1954 over prior years, with 1953 being the better of the two for both traits.

Year and Breeding Group No.	No.of Lambs	Fiber Diameter	Grade*	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)	Outer-coat Score
1949	628	28.7	54s	4.30	0.20	3.29	2.96
1950	720	27.0	58s	3.90	0.10	3.76	2.97
1951	250	25.5	60s	4.20	0.08	2.19	2.97
1952	493	28.3	56s	4.18	0.10	2.89	2.81
1949-52 Totals & Averages	2091	27.6	56s	4.12	0.13	3.23	2.98
1953 Group							
8	42	31.1	50s	4.32	0.06	3.49	2.19
9	41	30.4	50s	4.06	0.00	1.92	1.91
10	50	31.2	50s	3.99	0.00	0.81	1.83
11	28	31.3	50s	4.35	0.00	0.14	1.74
16	96	31.2	50s	3.99	0.00	1.58	1.94
Totals & Averages	257	31.1	50s	4.10	0.01	1.63	1.93
1954 Group							
8	40	26.6	58s	4.38	0.29	2.25	2.78
9	27	25.8	58s	3.86	0.34	4.52	2.00
10	39	26.3	58s	4.20	0.06	1.35	2.62
11	17	26.3	58s	4.11	0.00	0.09	2.61
16	137	26.0	58s	4.20	0.32	1.74	2.50
Totals & Averages	260	26.2	58s	4.19	0.26	1.94	2.51

* Grade for all years converted to latest ASTM Standards, adopted June 1953.



SELECTION PRACTICED ON COARSEWOOL, CROSSBRED WEANLING LAMBS

The selection differentials, relative emphasis and expected genetic gains per generation for the weanling lambs in research project 2 are given in the following table.

Weanling selection differentials are the average difference between the lambs saved and the total lambs weaned. It is important that these selection differentials be as large as possible since, for economic reasons, most of the effective selection must be accomplished at weanling age. This is especially true of the ewe lambs.

The relative emphasis placed on each trait at culling time is computed by dividing the selection differential by the standard deviation of that trait. The expected genetic gain was computed by multiplying the selection differential by the heritability estimate. The use of one half heritability times the selection differential for each sex and the sum of these products (or the average of the expected genetic gain as given in the table) gives the expected genetic gain per generation from selection practiced at weaning age on both sexes. By dividing these figures by the generation interval (average age of the sire and dam when lambs are born) the expected genetic gain per year is obtained. To be correct, the generation interval which should be applied to these data would be the age when these lambs produce offspring. Since this information is not available, it can only be estimated now from the average age of the present parents. It should also be pointed out that these gains from selection are only relative since all lambs saved at weaning will not produce progeny.

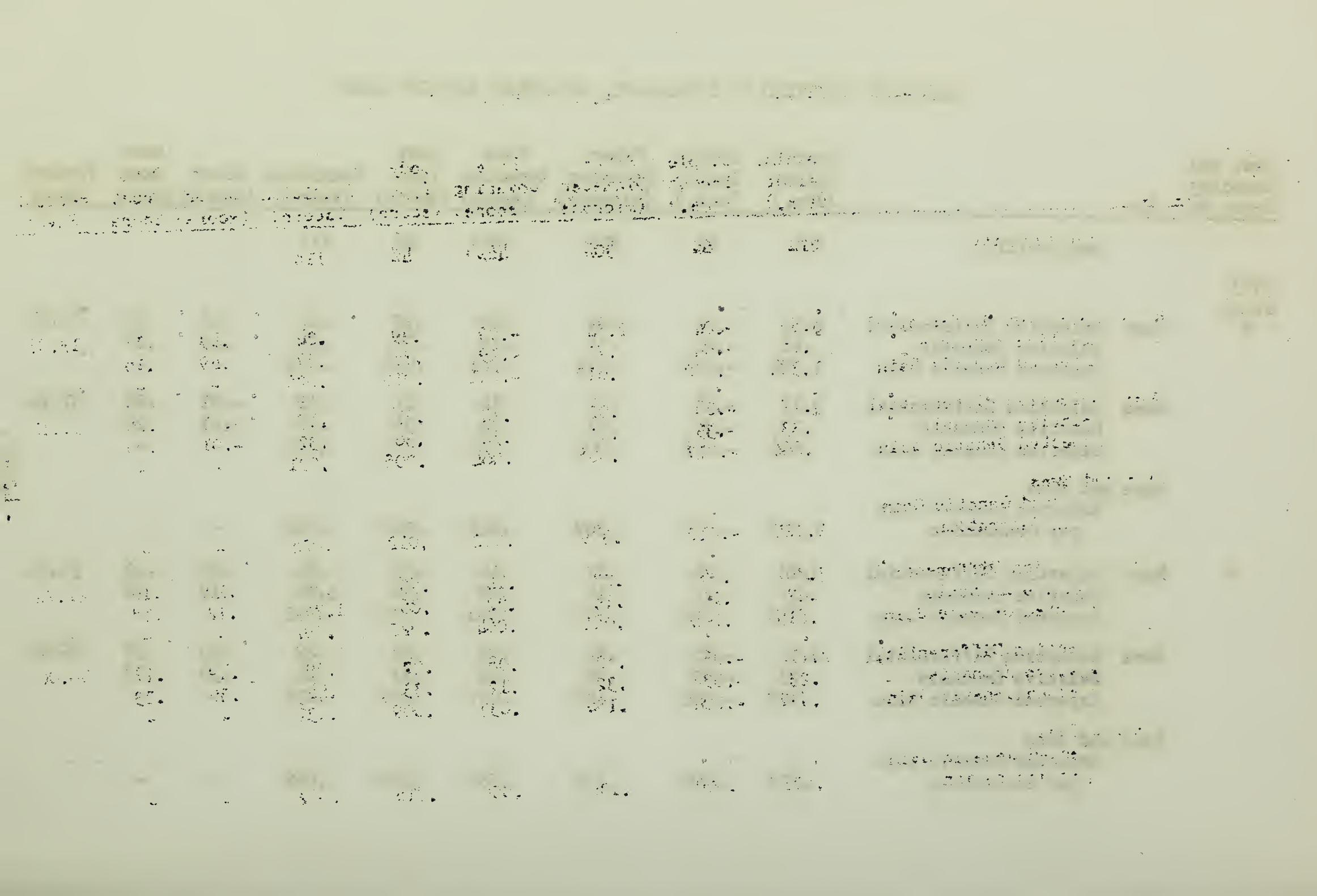
In general, the most emphasis has been placed on weaning weight and body type, condition, and outercoat scores. Selection differentials, relative emphasis and expected genetic gains for both sexes for weaning weight were larger in 1954 than in 1953. The selection differential and relative emphasis for outercoat score in ram lambs were also larger in 1954 than in 1953, while fiber diameter showed slightly larger gains in 1953. For most of the other traits there was little difference between the two years. In all traits most of the gains came through selection of the rams. Selection against outercoat and medullated fibers has resulted in slight selection pressure against staple length and fiber diameter in some instances.

Since an heritability estimate for face covering score has not been computed at this Station, the value obtained for range Targhee and Columbia lambs at Dubois, Idaho has been used. Thus the estimate for expected genetic gain is only accurate to the extent that the Dubois heritability is representative of the lambs at this Station.

In 1953, 31 ram lambs and 70 ewe lambs were saved from totals of 134 and 118 weaned, respectively. From totals of 126 ram lambs and 123 ewe lambs weaned in 1954, 32 and 59 were saved, respectively.

SELECTION PRACTICED ON COARSEWOOL, CROSSBRED YEANLING LAMBS

Year and Breeding Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat Score	Percent Saved
		Heritability	21%	6%	30%	46%*	4%	11%			
1953 Group 8	Rams	Selection Differential	6.59	-.04	2.04	-.09	.39	.24	.43	.15	19.05
		Relative Emphasis	.66	-.04	.71	-.19	.75	.37	.49	.16	
		Expected Genetic Gain	1.384	-.002	.612	-.041	.016	.026	-	-	
	Ewes	Selection Differential	3.17	-.28	.02	.14	.21	.19	-.01	.26	57.14
		Relative Emphasis	.33	-.35	.01	.34	.36	.32	-.01	.26	
		Expected Genetic Gain	.666	-.017	.006	.064	.008	.021	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.025	-.010	.309	.012	.012	.024	-	-	
9	Rams	Selection Differential	3.88	.06	.27	.14	.55	.84	.10	.16	21.74
		Relative Emphasis	.47	.11	.14	.22	.86	1.24	.12	.18	
		Expected Genetic Gain	.815	.004	.081	.064	.022	.092	-	-	
	Ewes	Selection Differential	2.51	-.06	.62	.08	.22	.29	.49	.17	50.00
		Relative Emphasis	.23	-.09	.32	.12	.33	.44	.36	.23	
		Expected Genetic Gain	.527	-.004	.186	.037	.009	.032	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.671	.000	.134	.050	.016	.062	-	-	



SELECTION PRACTICED ON COARSEWOOL, CROSSBRED WEANLING LAMBS, CONT.

Year and Breeding Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat Score	Percent Saved
1953, cont.											
Group 10	Rams	Selection Differential	6.59	.18	1.02	-.07	.34	.36	.15	.35	30.77
		Relative Emphasis	.64	.22	.37	-.20	.64	.68	.33	.51	
		Expected Genetic Gain	1.384	.011	.306	-.032	.014	.040	-	-	
	Ewes	Selection Differential	.80	-.14	.48	-.03	.11	.05	.05	.27	77.27
		Relative Emphasis	.14	-.17	.15	-.06	.29	.11	.09	.33	
		Expected Genetic Gain	.168	-.008	.144	-.014	.004	.006	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.776	.002	.225	-.023	.009	.023	-	-	
11	Rams	Selection Differential	1.00	-.31	-.04	.39	.15	.10	.17	.24	33.33
		Relative Emphasis	.14	-.30	.00	.59	.56	.22	.22	.44	
		Expected Genetic Gain	.210	-.019	-.012	.179	.006	.011	-	-	
	Ewes	Selection Differential	.90	.11	.78	-.08	.10	.20	.13	.40	66.67
		Relative Emphasis	.15	.11	.31	-.20	.25	.42	.14	.43	
		Expected Genetic Gain	.189	.007	.234	-.037	.004	.022	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.200	-.006	.111	.071	.005	.016	-	-	

SELECTION PRACTICED ON COARSEWOOL, CROSSBRED WEANLING LAMBS, CONT.

Year and Breeding Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat Score	Percent Saved
1953, cont.											
Group 16	Rams	Selection Differential	6.01	.06	-.53	.21	.34	.30	.20	.51	19.23
		Relative Emphasis	.72	.09	-.24	.48	.74	.54	.41	.61	
		Expected Genetic Gain	1.262	.004	-.159	.097	.014	.033	-	-	
	Ewes	Selection Differential	3.14	-.07	-.02	.04	.23	.27	.07	.19	52.38
		Relative Emphasis	.41	-.10	-.01	.09	.46	.47	.13	.26	
		Expected Genetic Gain	.659	-.004	-.006	.018	.011	.030	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.960	.000	-.082	.058	.012	.032	-	-	
1953 Totals	Rams	Selection Differential	5.25	.03	.61	.11	.36	.38	.20	.38	23.13
		Relative Emphasis	.58	.04	.24	.22	.71	.66	.30	.46	
		Expected Genetic Gain	1.102	.002	.183	.051	.014	.042	-	-	
	Ewes	Selection Differential	2.32	-.09	.35	.04	.20	.19	.12	.24	59.32
		Relative Emphasis	.29	-.12	.13	.08	.36	.35	.15	.29	
		Expected Genetic Gain	.487	-.005	.105	.018	.008	.021	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.794	-.002	.144	.034	.011	.032	-	-	

* Heritability estimate for face covering score as obtained for range Targhee and Columbia lambs at the U. S. Sheep Experiment Station, Dubois, Idaho.

SELECTION PRACTICED ON COARSEWOOL, CROSSBRED WEANLING LAMBS

Year and Breeding Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat Score	Percent Saved
		Heritability	21%	6%	30%	46%*	4%	11%			
1954 Group 8	**Rams**	Selection Differential	7.68	-.09	-.86	.37	-.11	.13	.25	.38	22.22
		Relative Emphasis	.87	-.11	-.49	.81	-.30	.33	.32	.34	
		Expected Genetic Gain	1.613	-.005	-.258	.170	-.004	.014	-	-	
	Ewes	Selection Differential	4.53	-.51	-.29	.01	.16	.23	-.01	.54	38.89
		Relative Emphasis	.64	-.32	-.13	.05	.41	.57	-.01	1.15	
		Expected Genetic Gain	.951	-.031	-.087	.005	.006	.025	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.282	-.018	-.172	.088	.001	.020	-	-	
9	**Rams**	Selection Differential	1.89	.35	-.31	-.27	.35	.30	.21	.19	30.77
		Relative Emphasis	.24	.44	-.15	-.61	.73	.45	.32	.16	
		Expected Genetic Gain	.397	.021	-.093	-.124	.014	.033	-	-	
	Ewes	Selection Differential	5.98	.26	.69	.00	.45	.35	.54	.36	42.86
		Relative Emphasis	.57	.32	.29	.00	.68	.58	.43	.38	
		Expected Genetic Gain	1.256	.016	.207	.00	.018	.038	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.826	.018	.057	-.062	.016	.036			

SELECTION PRACTICED ON COARSEWOOL, CROSSBRED WEANLING LAMBS, CONT.

Year and Breeding Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat Score	Percent Saved
1954, cont.											
Group 10	Rams	Selection Differential	10.49	.25	1.83	-.10	.40	.48	-.14	.99	22.22
		Relative Emphasis	.96	.29	.80	-.20	.74	1.00	-.18	1.14	
		Expected Genetic Gain	2.203	.015	.549	-.046	.016	.053			
	Ewes	Selection Differential	5.21	.27	.16	.13	.14	.18	.47	-.16	47.06
		Relative Emphasis	.44	.25	.08	.39	.19	.24	.54	-.15	
		Expected Genetic Gain	1.094	.016	.048	.060	.006	.020	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.648	.016	.298	.007	.011	.036	-	-	
11	Rams	Selection Differential	6.06	-.15	-.27	-.14	.27	.22	-.25	.46	41.67
		Relative Emphasis	.57	-.22	-.14	-.27	.53	.66	-.18	.50	
		Expected Genetic Gain	1.273	-.009	-.081	-.064	.011	.024	-	-	
	Ewes	Selection Differential	- - - - - - - - NONE SAVED -								0

SELECTION PRACTICED ON COARSEWOOL, CROSSBRED WEANLING LAMBS, CONT.

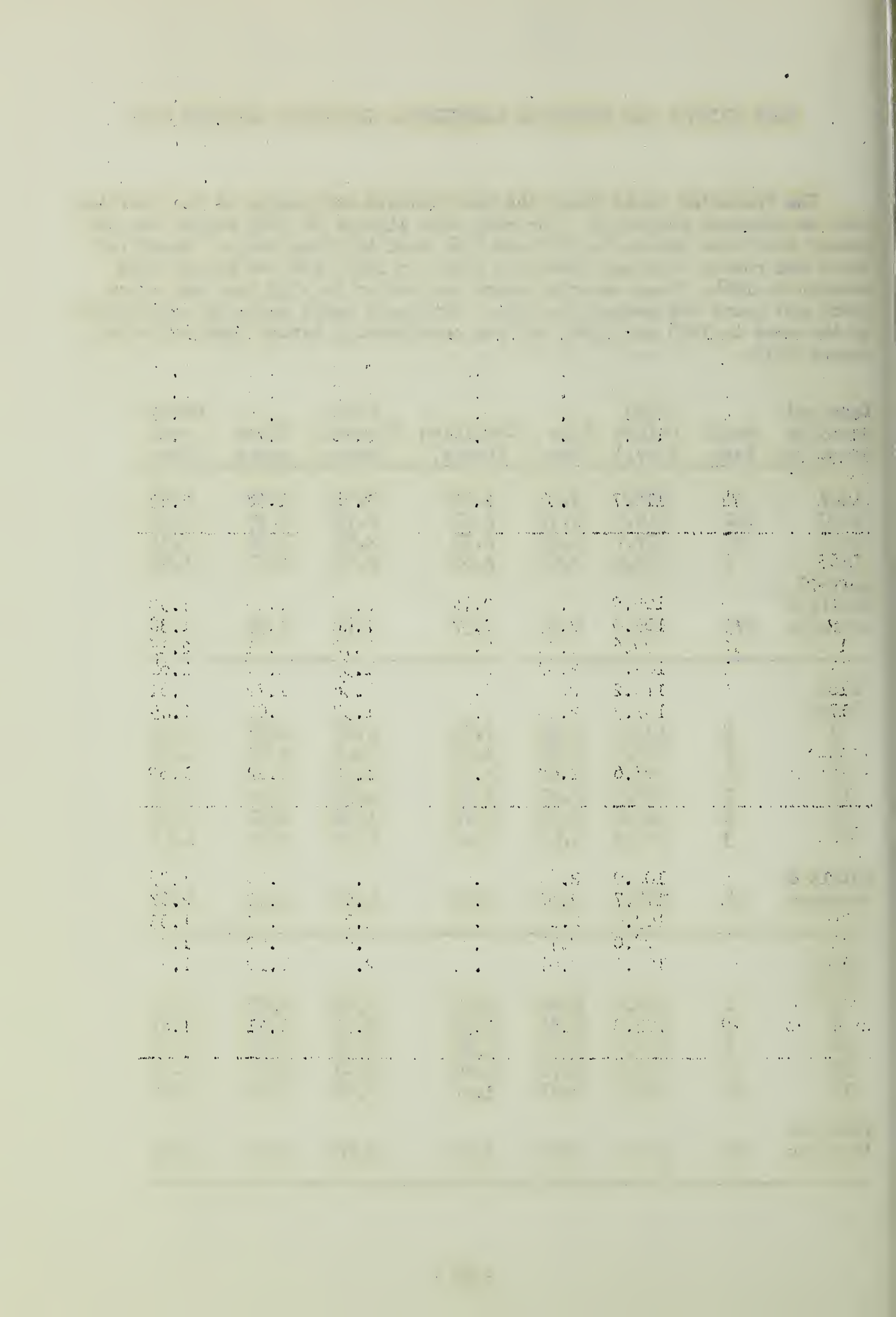
Year and Breeding Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat Score	Percent Saved
1954, cont. Group 16	Rams	Selection Differential	8.84	-.11	.31	.12	.39	.34	.05	.59	23.08
		Relative Emphasis	.84	-.14	.17	.28	.70	.63	.05	.60	
		Expected Genetic Gain	1.856	-.007	.093	.055	.016	.037	-	-	
	Ewes	Selection Differential	2.92	-.02	.16	.03	.17	.25	.02	.28	55.07
		Relative Emphasis	.33	-.03	.09	.07	.38	.48	.02	.28	
		Expected Genetic Gain	.613	-.001	.048	.014	.007	.028	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.234	.004	.070	.034	.012	.032	-	-	
1954 Totals	Rams	Selection Differential	7.95	-.03	.17	.04	.32	.32	.02	.59	25.40
		Relative Emphasis	.77	-.04	.09	.08	.61	.63	.02	.61	
		Expected Genetic Gain	1.670	-.002	.051	.018	.013	.035	-	-	
	Ewes	Selection Differential	3.68	-.02	.12	.03	.20	.26	.13	.27	47.97
		Relative Emphasis	.40	-.02	.06	.08	.39	.48	.13	.27	
		Expected Genetic Gain	.773	-.001	.036	.014	.008	.029	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.222	-.002	.044	.016	.010	.032	-	-	

* Heritability estimate for face covering score as obtained for range Targhee and Columbia lambs at the U. S. Sheep Experiment Station, Dubois, Idaho.

BODY WEIGHTS AND SCORES OF COARSEWOOL, CROSSBRED YEARLING RAMS

The following table shows the body weights and scores of the yearling rams in research project 2. The rams were lighter in body weight and had poorer body type scores in 1953 and 1954 than in prior years. Condition score was poorer than most previous years in 1953, but was better than average in 1954. Face covering score was better in 1953 than any other year, and above the average in 1954. Outercoat score averaged approximately the same in 1953 and 1954, and was considerably better than all years except 1952.

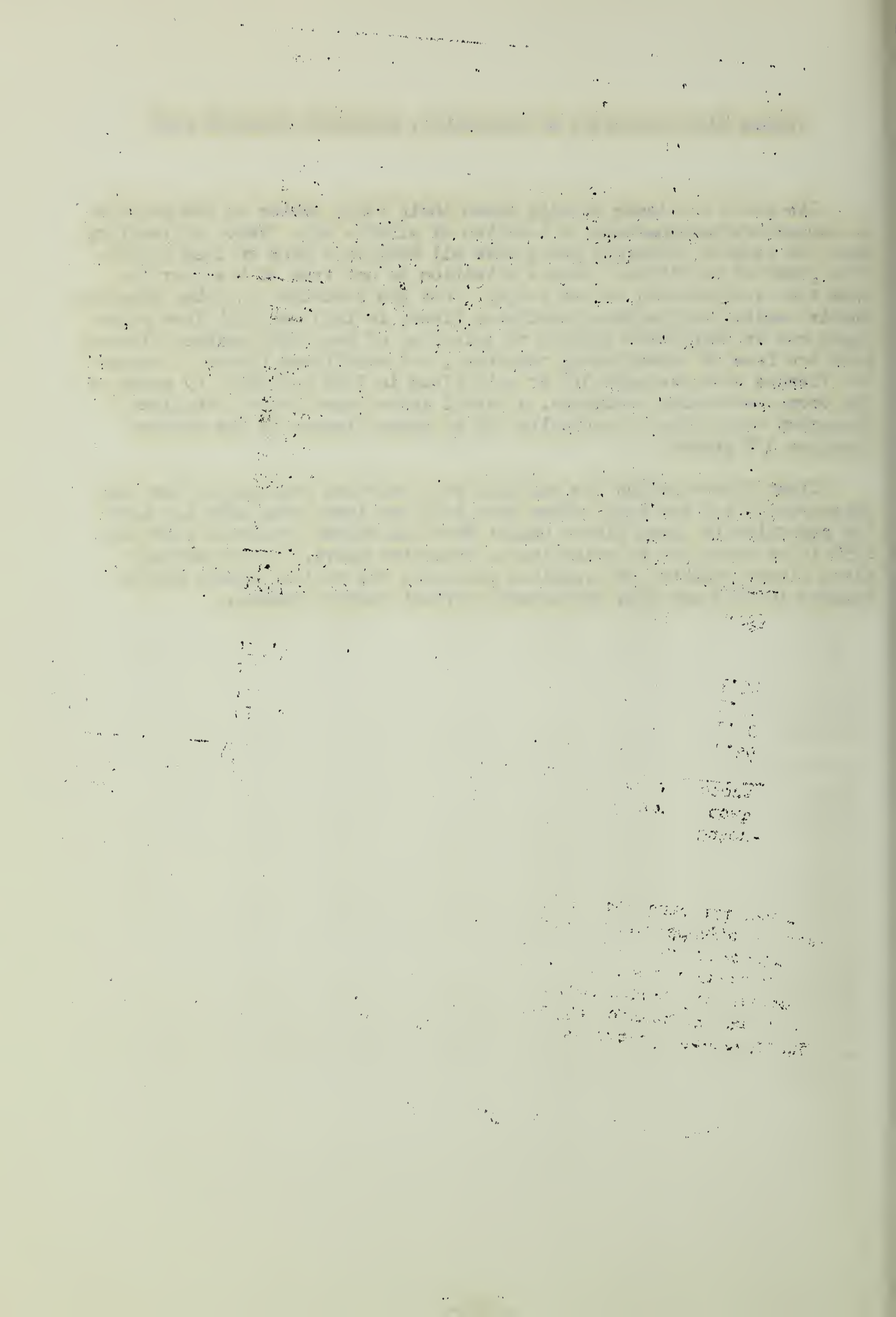
Year and Breeding Group No.	No.of Rams	Body Weight (lbs.)	Type Score	Condition (score)	Face Covering (score)	Color Score	Outer-coat Score
1949	98	126.0	2.21	2.20	2.63	1.38	2.56
1950	102	118.0	2.39	2.57	2.75	1.37	2.40
1951	66	109.7	2.32	2.70	2.96	1.36	2.81
1952	8	112.4	2.56	2.60	2.10	1.71	1.58
1949-52 Totals & Averages	274	118.7	2.31	2.47	2.74	1.38	2.53
1953 Group							
8	9	109.9	2.58	2.74	2.15	1.59	1.50
9	7	109.0	2.83	2.68	1.48	1.43	1.38
10	12	99.6	2.94	2.71	1.72	1.11	2.15
11	7	109.6	2.62	2.83	1.55	1.19	1.64
16	6	116.2	2.52	2.52	1.56	1.72	1.61
17	3	107.3	2.48	2.41	1.37	2.00	1.45
Totals & Averages	44	107.6	2.69	2.68	1.70	1.42	1.69
1954 Group							
8	4	102.0	2.89	2.56	2.96	1.00	1.75
9	3	114.7	2.82	2.37	1.95	1.00	2.67
10	8	103.6	2.44	2.36	2.38	1.62	1.33
11	4	98.0	2.78	2.30	2.00	1.00	1.75
16	10	105.3	2.67	2.37	2.08	1.10	1.58
Totals & Averages	29	104.3	2.63	2.38	2.26	1.21	1.67



FLEECE CHARACTERISTICS OF COARSEWOOL, CROSSBRED YEARLING RAMS

The saved ram lambs usually spend their first winter in the corrals at Laboratory headquarters on a ration of alfalfa hay. Hence at yearling age, the rams of different years have all been on a more or less comparable plane of nutrition. Such a situation is not true of the yearling ewes that are wintered on the range. Thus the reduction in fiber diameter, staple length, and percent medullated fibers in 1953 and 1954 from prior years can be attributed largely to selection of rams with uniform fleeces that are free of breechiness, outercoat, and medullated fibers. Whereas the fleeces have averaged 3/8 or half blood in 1953 and 1954, by means of the cross sectioning technique, a visual grade based largely on fleece character would place practically all of these fleeces in the quarter blood or 3/8 grade.

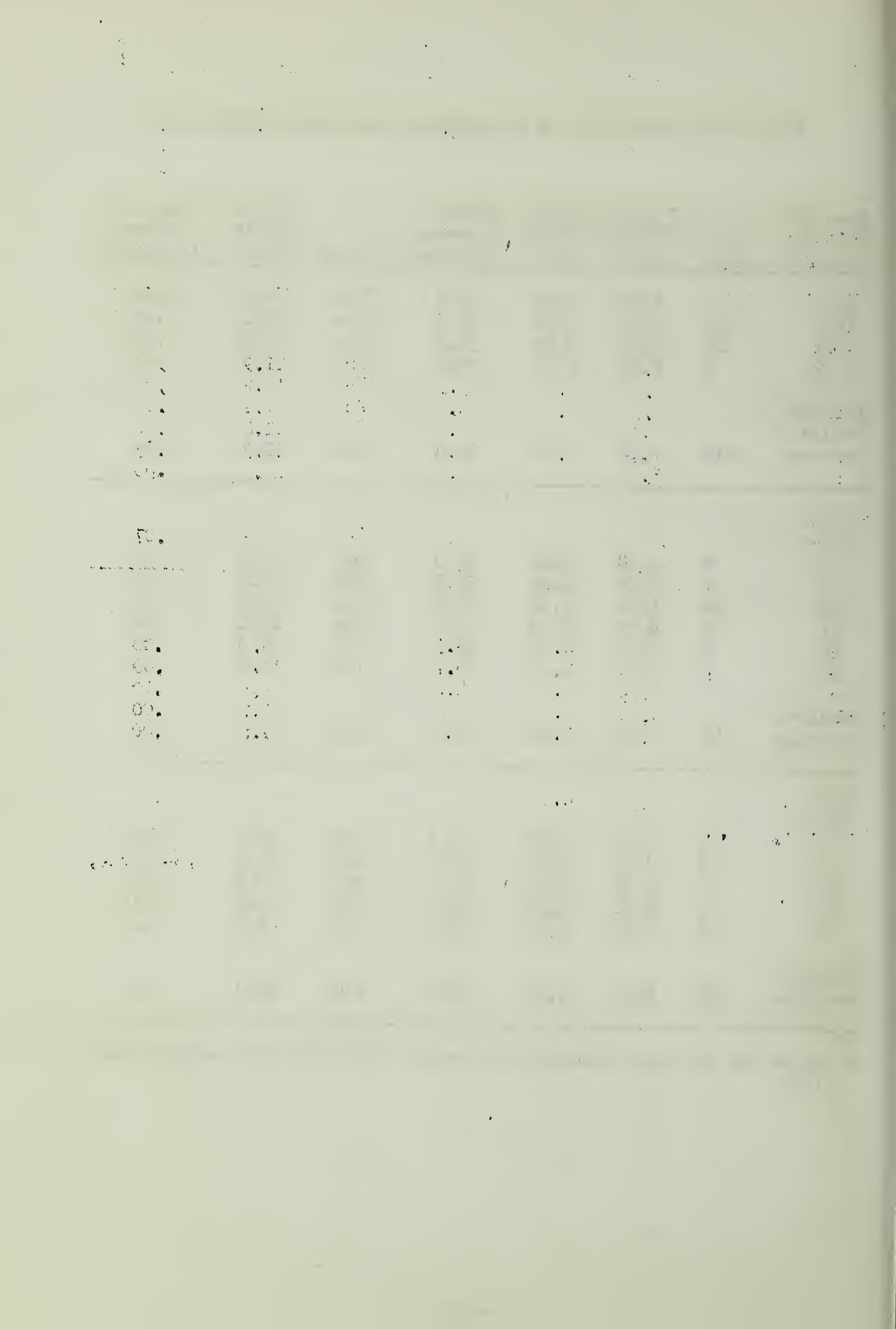
Clean fleece weight has remained at a constant average for the past three years, and has been better than 1951 but lower than 1949 and 1950. The reduction in clean fleece weight from the higher levels of 1949 and 1950 is no doubt due to selection as described above. As the average clean fleece weights have remained constant, the smaller grease fleece weights in 1953 and 1954 undoubtedly reflect cleaner fleeces.



FLEECE CHARACTERISTICS OF COARSEWOOL, CROSSBRED YEARLING RAMS

Year and Breeding Group No.	No. of Rams	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Grade*	Staple Length (cms.)	Other Med. Fibers (percent)
1949	101	9.40	6.46	30.8	50s	12.4	0.60
1950	102	9.28	5.61	29.7	54s	13.4	.20
1951	66	8.67	3.93	30.4	50s	11.8	.29
1952	8	8.28	4.54	30.8	50s	11.5	.00
1949-52 Totals & Averages	277	9.15	5.49	30.3	50s	12.6	0.36
1953 Group							
8	9	7.18	4.49	29.3	54s	11.9	.00
9	7	6.86	4.49	26.3	58s	11.2	.00
10	12	5.96	4.26	28.8	54s	11.4	.00
11	7	6.79	4.93	29.0	54s	11.4	.00
16	6	8.12	5.04	30.6	50s	10.3	.53
17	3	5.87	4.15	32.8	48s	10.9	.00
Totals & Averages	44	6.77	4.54	29.0	54s	11.3	.07
1954 Group							
8	4	6.46	4.66	25.3	60s	10.6	.00
9	3	7.30	5.70	26.7	58s	11.1	.00
10	8	5.75	4.28	24.2	60s	9.8	.00
11	4	6.26	4.44	26.4	58s	11.0	.00
16	10	6.14	4.43	24.5	60s	9.6	.00
Totals & Averages	29	6.21	4.56	25.0	60s	10.1	.00

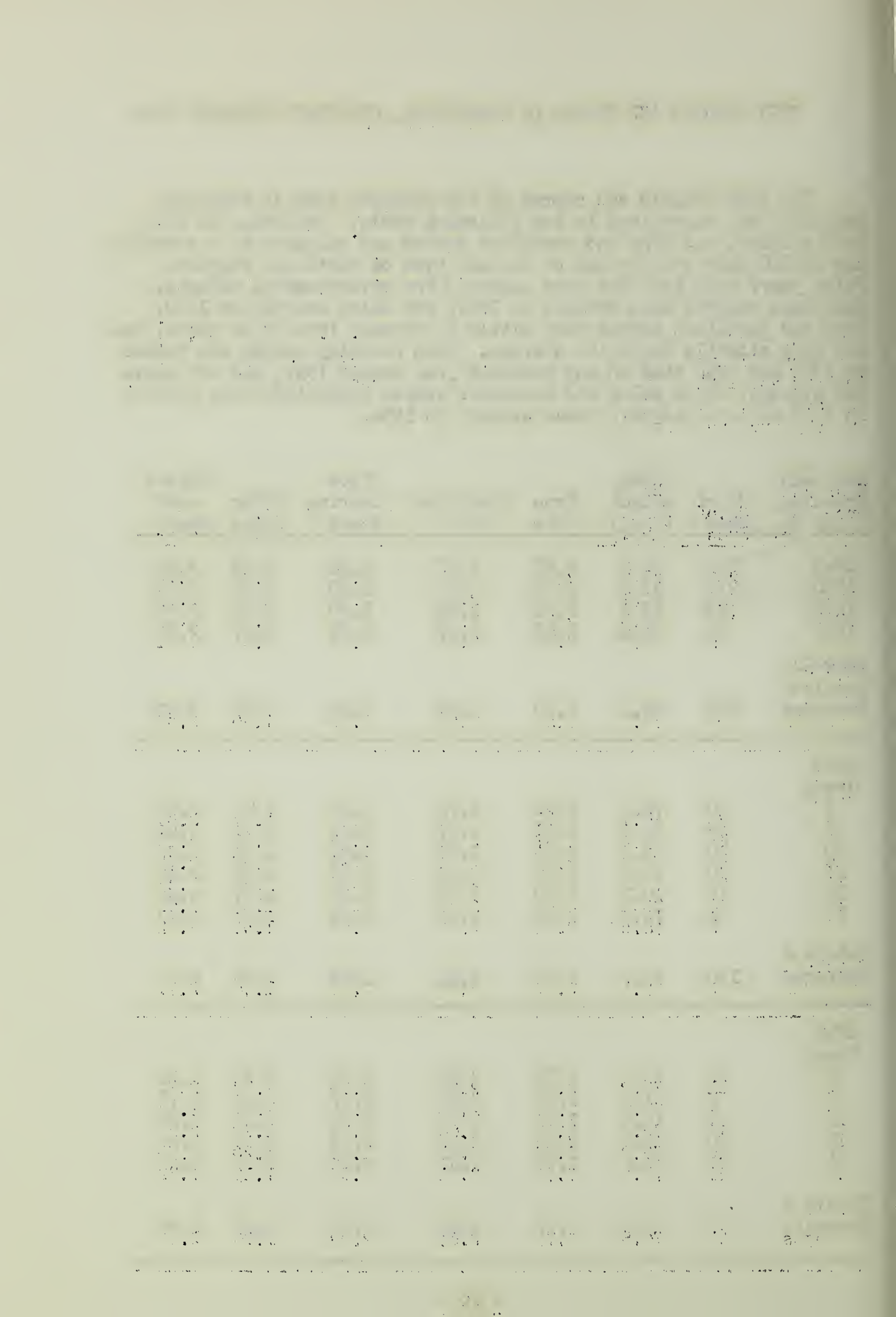
* Grade for all years converted to latest ASTM Standards, adopted June, 1953.



BODY WEIGHTS AND SCORES OF COARSEWOOL, CROSSBRED YEARLING EWES

The body weights and scores of the yearling ewes in research project 2 are summarized in the following table. Beginning in 1954, body weights, and type and condition scores are adjusted to a constant age of 400 days and for age of dam and type of birth and rearing. Prior years data have not been adjusted for environmental effects. June body weights were average in 1954, but below average in 1953. Type and condition scores show little difference from prior years, but are very slightly below the average. Face covering scores are better in 1953 and 1954 than in any previous year except 1952, and are above the average, while color and outercoat scores approximate the average in 1953 and are slightly above average in 1954.

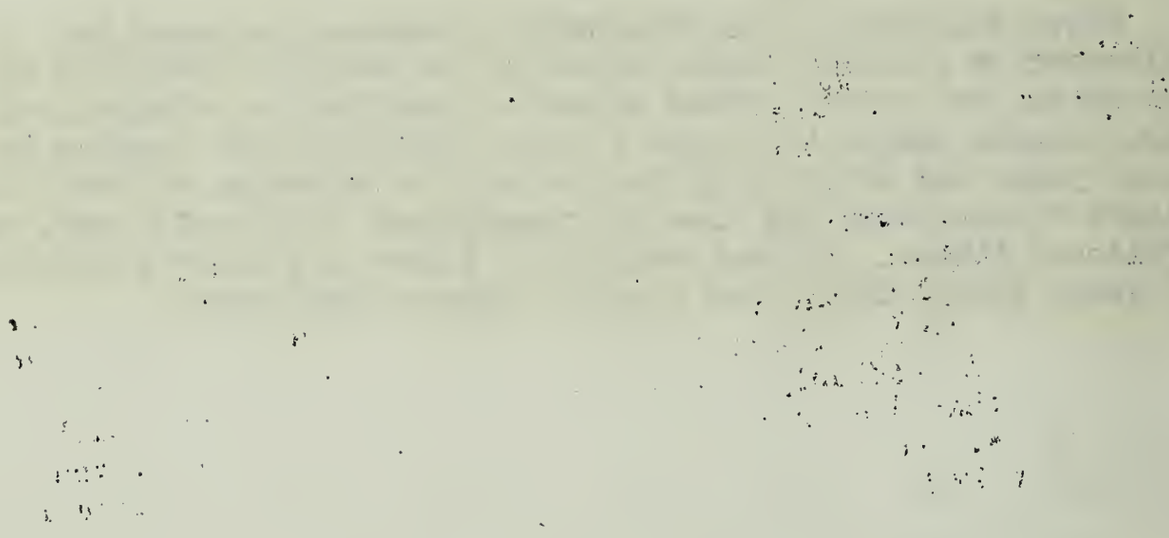
Year and Breeding Group No.	No. of Ewes	Body Weight (lbs.)	Type Score	Condition Score	Face Covering Score	Color Score	Outer-coat Score
1949	260	85.4	2.22	2.27	2.34	1.38	2.74
1950	219	83.1	2.36	2.59	2.80	1.41	2.78
1951	189	53.5	2.70	2.94	2.90	1.40	2.89
1952	34	86.4	2.45	2.39	1.97	2.67	2.81
1949-52 Totals & Averages	702	76.1	2.40	2.56	2.62	1.46	2.80
1953 Group							
8	30	74.1	2.61	2.72	2.30	1.47	2.85
9	19	73.2	2.57	2.77	1.73	1.67	2.46
10	40	73.2	2.65	2.80	1.90	1.38	2.75
11	20	71.0	2.74	2.93	2.17	1.32	2.85
16	17	70.1	2.80	2.86	2.28	1.57	2.64
17	4	74.8	2.81	2.89	1.54	1.50	2.82
Totals & Averages	130	72.7	2.67	2.81	2.05	1.46	2.71
1954 Group							
8	11	75.9	2.78	2.69	2.70	1.73	2.74
9	9	77.5	2.88	2.63	2.17	1.11	1.78
10	16	78.8	2.77	2.60	1.74	1.20	2.22
11	10	75.2	2.90	2.67	1.85	1.20	1.99
16	21	75.4	2.71	2.61	2.08	1.15	1.72
Totals & Averages	67	76.5	2.79	2.63	2.09	1.26	2.06



FLEECE CHARACTERISTICS OF COARSEWOOL, CROSSBRED YEARLING EWES

As only one ewe fleece possessed kemp fibers (1.49 percent) in 1953 and none in 1954, this trait is no longer included in the table which follows. Clean fleece weights are adjusted to a constant age of 365 days and for 12 percent moisture content for all years, and in addition, are also adjusted for age of dam and type of birth and rearing in 1953 and 1954. Grease fleece weights and staple lengths are adjusted to 365 days of age for all years and for age of dam and type of birth and rearing in 1953 and 1954. Clean fleece weights averaged approximately the same in 1953 and 1954 as in 1952, but were lower than in 1949 and 1950. Grease fleece weights were smaller in 1953 and 1954 than in any of the other years except 1951.

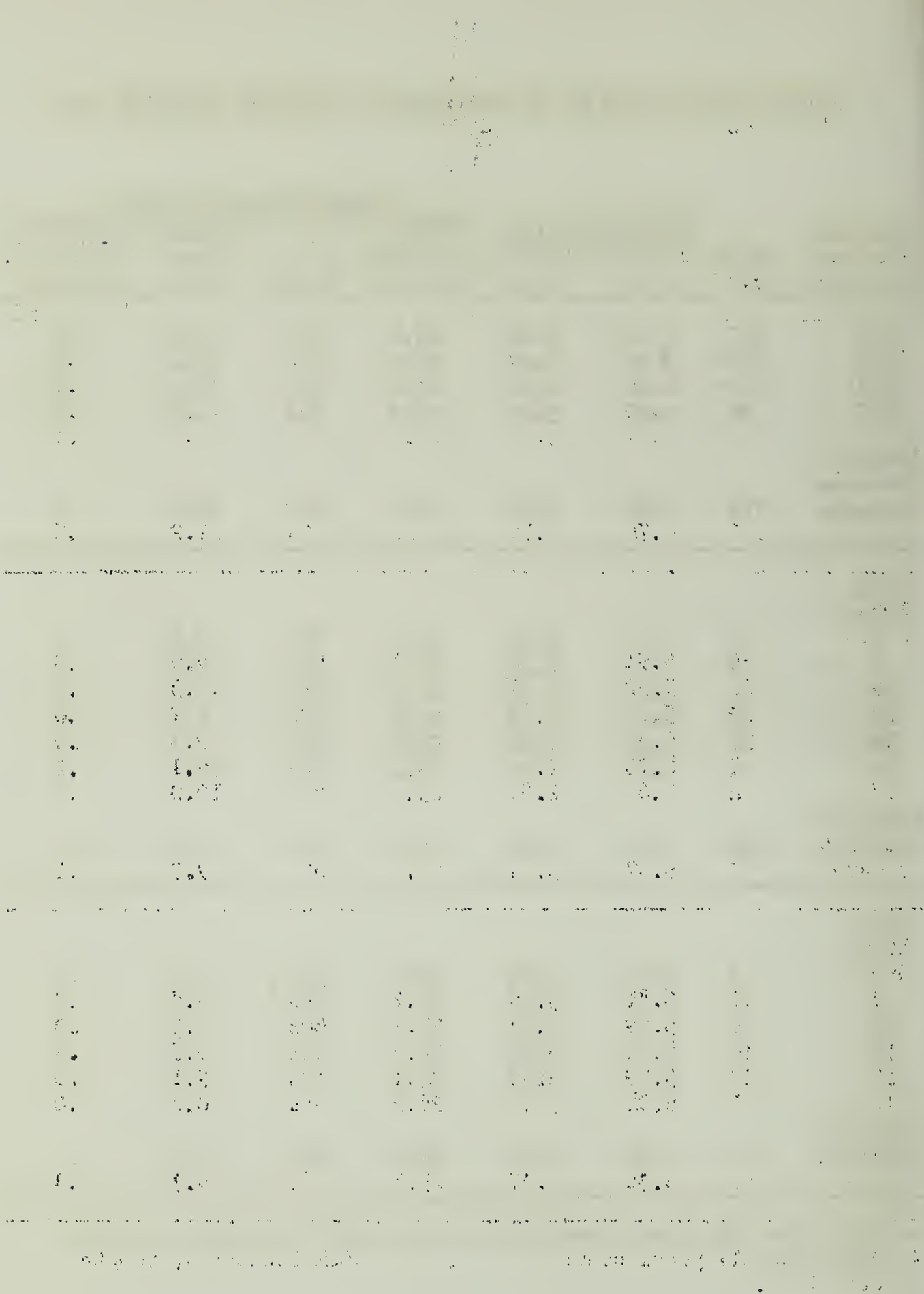
Fiber diameter varies considerably between years and is influenced to a rather large degree by the plane of nutrition of the ewes during the winter months preceding sampling in mid-April of each year. Staple length has shown a trend toward shorter lengths in recent years and is probably due in part to selection of ewes with uniform fleeces that are free of breechiness, outercoat, kemp, and medullated fibers. Percent medullated fibers has shown a decline in all years except 1954, when a small increase was noted.



FLEECE CHARACTERISTICS OF COARSEWOOL, CROSSBRED YEARLING EWES

Year and Breeding Group No.	No. of Ewes	Fleece Weights		Fiber Traits at Side			
		Grease (lbs.)	Clean (lbs.)	Fiber Diameter (microns)	Grade*	Staple Length (cms.)	Other Med. Fibers (percent)
1949	260	7.06	4.66	25.1	60s	10.8	0.9
1950	219	8.14	4.09	25.0	60s	12.0	.4
1951	189	4.65	2.32	20.6	70s	11.2	.3
1952	34	6.87	3.37	29.8	54s	8.9	.1
1949-52 Totals & Averages	702	6.74	3.79	24.1	60s	11.2	.5
1953 Group							
8	30	5.91	3.52	24.1	60s	9.6	.0
9	19	5.52	3.31	22.8	62s	10.3	.2
10	40	5.09	3.31	24.5	60s	9.7	.0
11	20	5.67	3.68	25.7	58s	9.8	.0
16	17	4.73	2.84	23.8	62s	9.1	.2
17	4	4.66	2.88	25.2	60s	10.0	.0
Totals & Averages	130	5.37	3.34	24.3	60s	9.7	.1
1954 Group							
8	11	5.81	3.84	25.7	58s	9.8	.7
9	9	5.59	3.28	25.1	60s	9.3	.0
10	16	4.74	3.24	26.3	58s	9.5	.9
11	10	5.79	3.54	24.1	60s	9.1	.0
16	21	5.04	3.15	26.2	58s	8.8	.0
Totals & Averages	67	5.30	3.37	25.7	58s	9.3	.3

* Grade for all years converted to latest ASTM Standards, adopted June 1953.

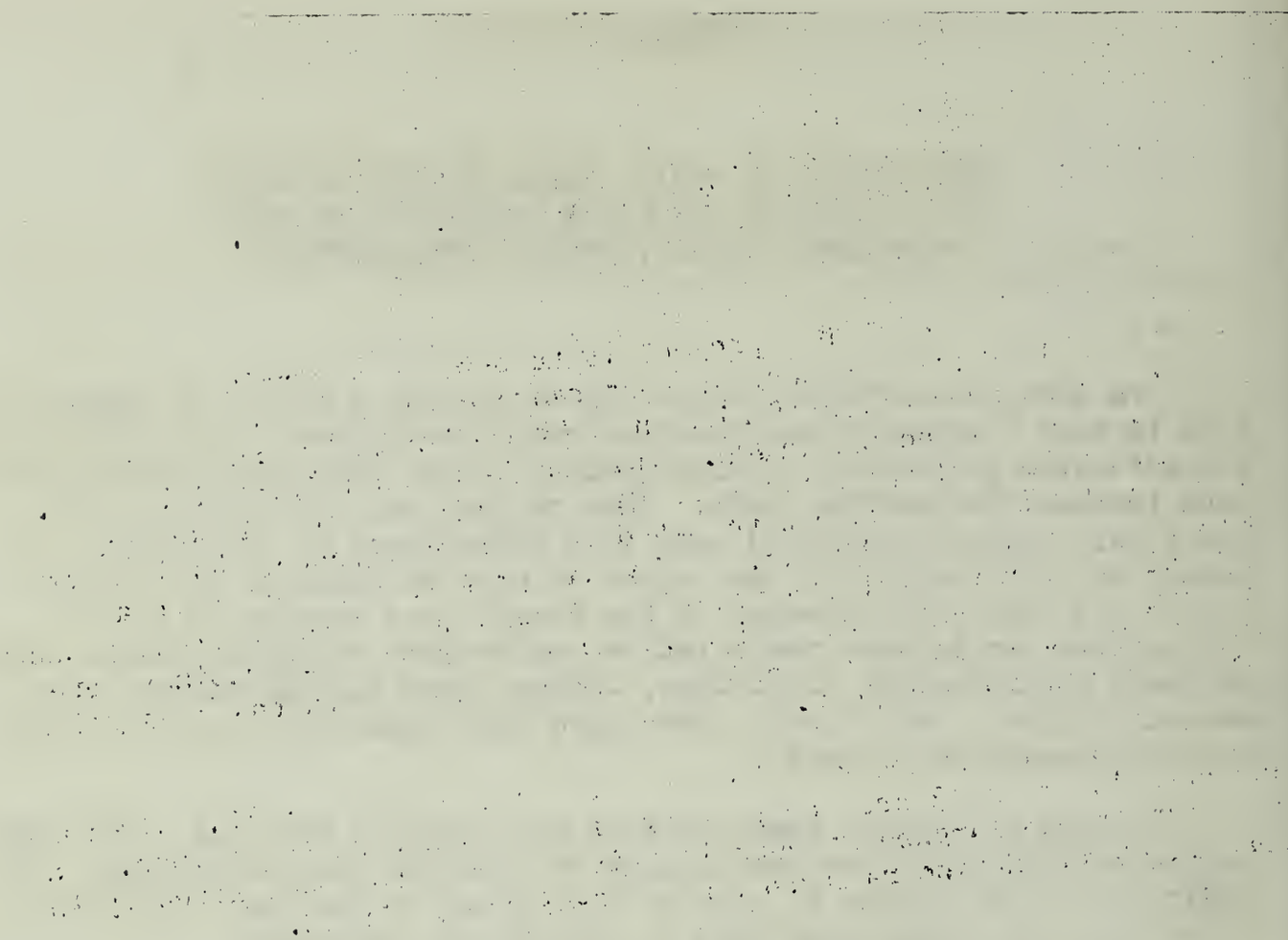


RESEARCH PROJECT 3

IMPROVEMENT OF NAVAJO SHEEP BY CROSSBREEDING AND SELECTION FOR RANGE PRODUCTION OF WOOL AND LAMBS SUITED TO MARKET REQUIREMENTS.

The objective of this project is to develop a strain of sheep that will be well adapted to southwestern range conditions, with inheritance for efficient production of high quality feeder lambs and combing length wool between 60s and 62s grade. This project was initiated in 1948. The finest fleeced crossbred ewes with inheritance of 1/2 Navajo, 1/4 Romney and 1/4 Corriedale were mated to rams of Targhee, New Zealand Merino and Debouillet breeds. A few Navajo ewes were mated to a Rambouillet ram to test the relative performance of these crosses under the same environmental conditions. Since these initial matings were made in 1948-49, only Targhee rams have been used with the ewes going into this research project.

The use of Targhee rams has been continued in group 12. The rams and ewes in group 13 are the progeny of previous Targhee matings. In addition to the Targhee F_1 ewes in this group, a few ewes sired by the Debouillet and Merino rams used in 1948-49 are included.



CHARACTERISTICS OF FINEWOOL CROSSBRED BREEDING RAMS

Numbers of rams used in each breeding group, their body weight at breeding, age at lambing time, and fleece characteristics at yearling age are given in the following table. Group 13 rams are F_1 Targhee crossbred rams, and there were four of them used in 1954, two each in 1953 and 1952, and one each in 1951 and 1950. Other groups are pure-bred Targhee, Merino, Debouillet, and Rambouillet rams which were obtained from the Western Sheep Breeding Laboratory, Dubois, Idaho and from private breeders.

Year and Breeding Group No.	No. of Rams	Age at Lambing Time (years)	Body Wt. at Breeding (lbs.)	Yearling Fleece Weights		Yearling Fiber Traits at Side		
				Grease (lbs.)	Clean (lbs.)	Fiber Dia. (microns)	Grade*	Staple Length (cms.)
1949	4	3.2	-	13.02	6.84	22.2	64s	12.2
1950	5	4.0	189.8	12.69	6.92	22.2	64s	12.2
1951	12	3.0	194.9	10.83	5.10	22.2	64s	8.8
1952	5	4.0	185.0	10.98	4.68	22.0	64s	9.6
1952**	3	2.7	188.0	19.22	6.68	24.6	60s	9.6
1949-52	29	3.3	191.1	12.35	5.74	22.4	64s	10.1
1953								
Group 12	2	5.5	208.0	12.85	6.25	21.0	70s	10.1
Group 13	2	3.0	187.0	9.49	4.90	23.8	62s	9.4
Totals	4	4.2	197.5	11.17	5.58	22.4	64s	9.8
1954								
Group 12	2	4.5	209.5	11.75	5.65	24.6	60s	8.1
Group 13	4	3.0	156.8	9.34	5.13	26.6	58s	9.8
Totals	6	3.5	174.3	10.31	5.30	25.9	58s	9.2

* Grade for all years converted to latest ASTM standards, adopted June, 1953.

** Three of the rams used in 1952 were purchased from private breeders and yearling records were not available. Fleece traits listed are their 2-year-old record.

CHARACTERISTICS OF FINEWOOL CROSSBRED BREEDING EWES

Average age of the ewes at lambing, body weight at 18 months, and yearling fleece characteristics of the breeding ewes in research project 3 are summarized by years and breeding groups in the following table.

Grease fleece and clean fleece weights exceeded the 1949-1952 average in both 1953 and 1954, with 1953 being the better of the two years and the best on record for both traits. With the increase in fleece weights, there appears to be a slight increase in fineness and decrease in staple length, although fiber diameter measurements are influenced somewhat by winter range feed conditions. The percentage of medullated fibers has been steadily decreasing since 1951. Kemp fibers, which have never exceeded 0.1 percent, were practically non-existant in 1953 and 1954, and are no longer reported. The decrease in body weight is probably due primarily to short range feed in both 1953 and 1954.

Year and Breeding Group No.	No. of Ewes	Age at Lambing Time (years)	Body Wt. at 18 Mos. (lbs.)	Yearling Fleece Weights		Yearling Fiber Traits at Side		
				Grease (lbs.)	Clean (lbs.)	Grade	Staple Length (cms.)	Med. Fibers (percent)
1949	127	5.2	108.8	5.76	3.22	60s	8.2	0.5
1950	156	5.8	107.5	5.48	3.07	60s	8.4	0.6
1951	390	4.9	101.9	6.29	2.94	56s	11.2	2.0
1952	243	4.5	102.7	6.90	3.21	58s	9.9	1.5
1949-52	916	5.0	104.0	6.24	3.07	58s	10.0	1.4
1953								
Group 12	58	5.6	107.4	7.26	4.03	58s	9.8	1.7
Group 13	45	2.9	97.6	6.74	3.04	64s	8.4	.0
Totals	103	4.4	103.1	7.04	3.60	60s	9.2	1.0
1954								
Group 12	40	6.0	105.3	6.91	4.01	60s	10.2	1.8
Group 13	79	2.9	98.6	6.41	3.01	70s	8.4	.0
Totals	119	3.9	100.9	6.58	3.37	64s	9.0	0.6

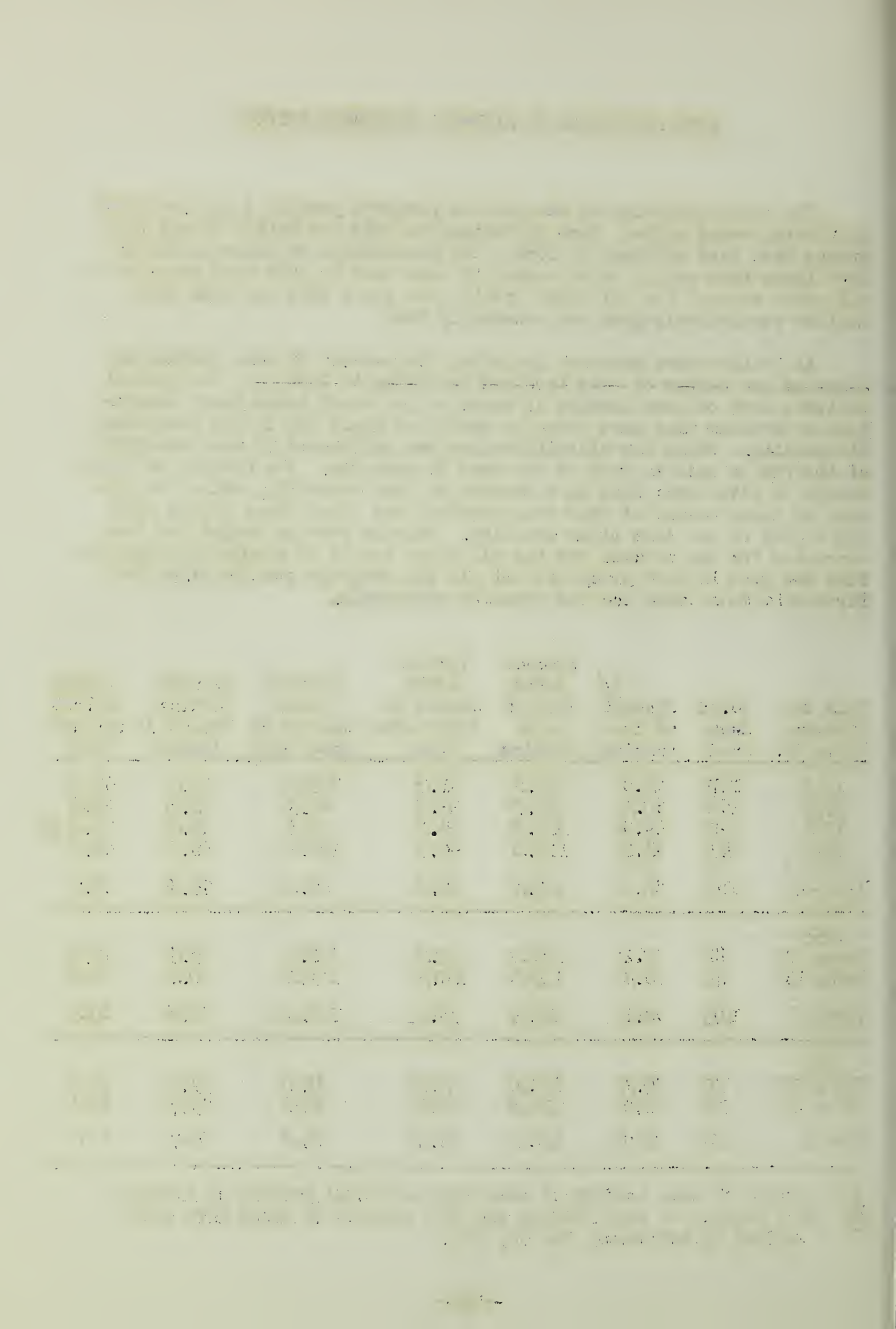
LAMB PRODUCTION OF FINEWOOL CROSSBRED MATINGS

The lamb production of the ewes in research project 3 is summarized in the following table. Lamb production in 1953 was better in all respects than that obtained in 1954. The percentages of lambs weaned of live lambs born and of lambs weaned of ewes bred in 1953 were superior to all other years. For all other traits, the years 1953 and 1954 were neither particularly good nor especially bad.

As in the other research projects, the percent of ewes lambing is based on the number of ewes bred and surviving to lambing. The percent of lambs born of ewes lambing is based on the total lambs born, regardless of whether they were alive or dead, and minus 100 is the percentage of twinning. These two classifications are influenced by the fertility of the ram as well as that of the ewes in each pen. The percent of lambs weaned of live lambs born is a measure of lamb mortality, while the percent of lambs weaned of ewes bred combines the first three values plus any effect of ewe loss after breeding. Average weaning weight has been corrected for age of dam, but for all other traits it should be remembered that the ewes in each group are not all the same age and therefore the figures in this table are not directly comparable.

Year and Breeding Group No.	No. of Ewes Bred	Percent of Ewes Lambing 1/	Percent Lambs Born of Ewes Lambing	Percent Lambs Weaned of Live Lambs Born	Percent Lambs Weaned of Ewes Bred	Average Weaning Weight in Pounds	Pounds of Lamb per Ewe Bred
1949	127	92.0	147.8	81.5	107.9	62.1	67.0
1950	156	63.9	144.7	73.3	63.5	45.3	28.8
1951	390	89.8	105.8	34.6	32.1	35.8	11.5 2/
1952	243	94.2	119.4	90.7	100.4	66.1	66.3
1949-52	916	87.0	120.7	64.8	66.0	55.5	36.7
1953							
Group 12	58	91.2	126.9	93.9	106.9	59.5	63.6
Group 13	45	90.0	133.3	100.0	109.5	57.4	62.8
Totals	103	90.7	129.5	96.4	108.0	58.6	63.3
1954							
Group 12	40	85.7	140.0	73.2	75.0	59.1	44.3
Group 13	79	92.0	118.8	88.6	88.6	55.7	49.4
Totals	119	90.0	125.3	83.3	84.0	56.7	47.7

1/ Percent of ewes lambing of ewes bred and still present at lambing.
2/ 29.7 percent of ewes lambing and 52.9 percent of lambs born alive killed by hailstorm, May 30, 1951.

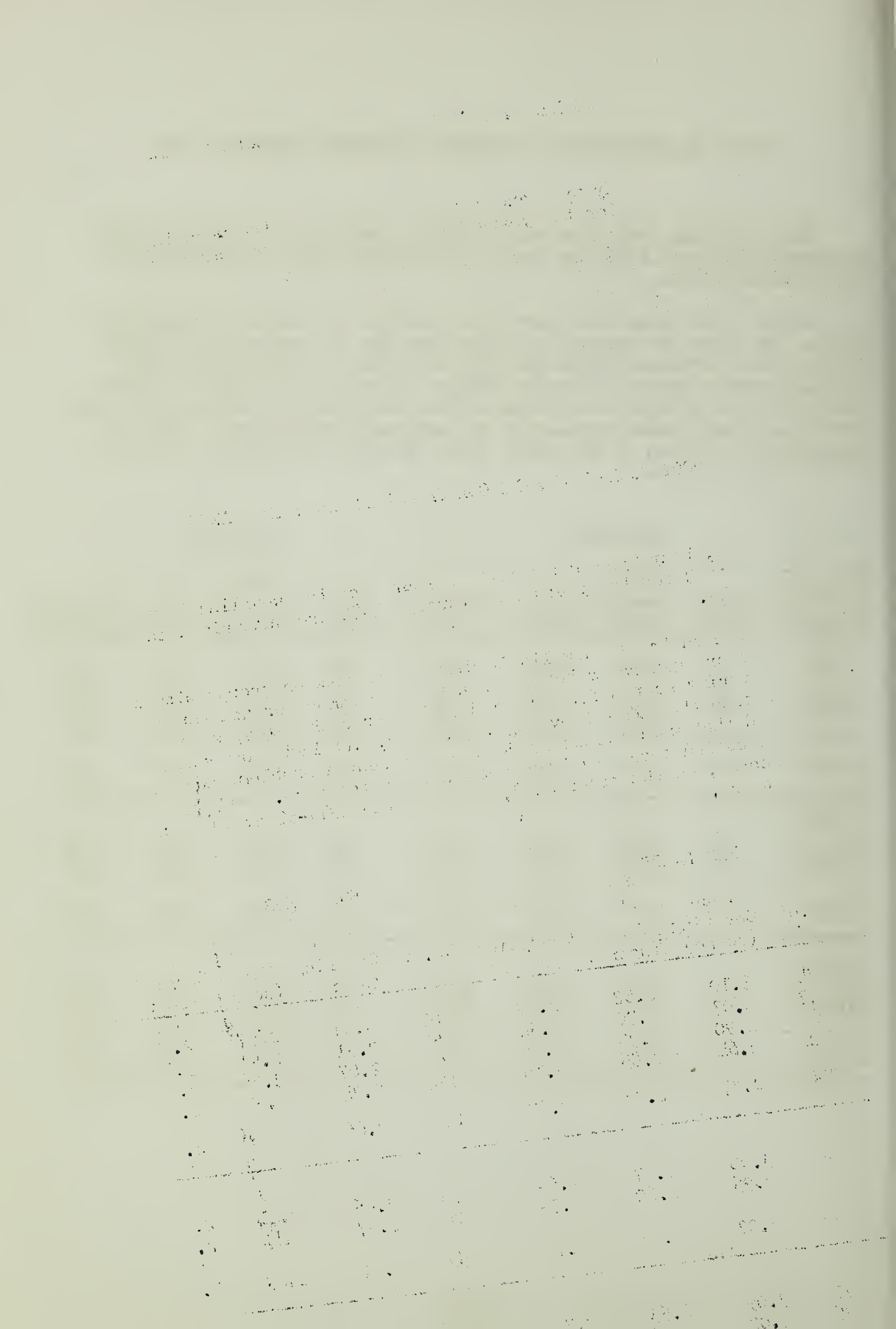


FACE AND BODY SCORES OF FINEWOOL CROSSBRED WEANLING LAMBS

Face covering, body type and condition scores of the weanling lambs in research project 3 for the years 1949 through 1954 are summarized in the following table.

Averages for each trait show little difference between groups within sexes. Ewe lambs are generally better than the ram lambs for all three traits. Face covering scores for 1953 and 1954, for both sexes, were slightly poorer than the 1949-52 average. However, all lambs are sufficiently open-faced that wool blindness does not present a problem, and only rarely is a lamb culled because of too much wool on the face. Body type and condition scores, on the other hand, exceeded the 1949-52 average in all but one instance.

	RAM LAMBS				EWE LAMBS			
Year and Breeding Group No.	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)
1949	74	3.10	2.52	2.49	63	3.04	2.57	2.39
1950	47	3.07	3.70	2.94	52	2.91	2.91	3.58
1951	61	2.90	3.25	3.36	64	2.67	3.26	3.20
1952	124	2.64	2.85	3.16	120	2.34	2.31	2.47
1949-52	306	2.87	2.98	2.87	299	2.66	2.67	2.80
1953								
Group 12	36	3.06	2.47	2.69	26	2.85	2.41	2.58
Group 13	20	2.95	2.60	2.73	26	2.97	2.56	2.71
Totals	56	3.02	2.52	2.71	52	2.91	2.49	2.65
1954								
Group 12	11	3.09	2.53	2.75	19	2.90	2.55	2.73
Group 13	35	3.02	2.36	2.64	35	3.01	2.72	2.92
Totals	46	3.04	2.40	2.67	54	2.97	2.66	2.86



FLEECE CHARACTERISTICS OF FINEWOOL CROSSBRED WEANLING LAMBS

The following table summarizes the fleece characteristics of the weanling lambs in research project 3. Only small differences occur between breeding groups within years for most of the traits, but differences between years are sometimes rather sizeable. This is particularly true of fiber diameter which is affected to a greater degree by yearly environmental differences. Although the averages of both groups in 1953 and 1954 showed less outercoat fibers than in any previous year, the lambs are still not as uniform with respect to fleece type as desired. Further selection against outercoat and medullated fibers will no doubt result in finer fleeces and a somewhat shorter staple length.

Year and Breeding Group No.	No. of Lambs	Fiber Diameter	Grade*	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)	Outercoat (score)
1949	137	24.2	60s	3.40	.10	.50	2.26
1950	99	23.0	62s	3.00	.10	.90	2.10
1951	125	21.7	64s	3.50	.14	1.39	2.14
1952	244	25.2	60s	3.22	.14	.88	1.78
1949-52	605	23.9	62s	3.28	.12	.90	2.02
1953							
Group 12	62	26.8	58s	3.09	.12	.93	1.13
Group 13	46	26.7	58s	3.05	.00	.72	1.28
Totals	108	26.8	58s	3.07	.07	.84	1.19
1954							
Group 12	30	24.5	60s	3.12	.29	.27	1.43
Group 13	70	23.2	62s	3.04	.23	.76	1.39
Totals	100	23.6	62s	3.06	.25	.61	1.40

* Grade for all years converted to latest ASTM standards, adopted June, 1953.

SELECTION PRACTICED ON FINEWOOL CROSSBRED WEANLING LAMBS

The selection differentials, relative emphasis placed on each trait, and the expected genetic gain per generation for the weanling lambs in research project 3 are presented in the following table. Computational procedures used are described in the preceding section (Page 39). As previously noted, the heritability estimate for face covering score is that obtained at the U. S. Sheep Experiment Station at Dubois, Idaho for range Targhee and Columbia lambs. For that reason, the estimate of expected genetic gain is only accurate to the extent that the Dubois heritability estimate pertains to the lambs at Fort Wingate.

In 1953, 10 ram lambs and 30 ewe lambs were saved from totals of 56 and 52 weaned, respectively. In 1954, 14 ram lambs and 27 ewe lambs were saved from totals of 46 and 53 weaned, respectively.

In general, greatest emphasis was placed on weaning weight, body type, and condition scores for the ram lambs, and on body type, and condition and outercoat scores for the ewe lambs. In 1953, considerable emphasis was placed on fiber diameter for both sexes in breeding group 13.

Contrary to some prior years, negative selection differentials for fiber diameter indicate selection of lambs with finer fleeces. This is not undesirable for this project. Negative selection differentials for staple length indicate that the lambs saved had shorter staple, on the average, than the average of all lambs. This consequence probably results in part from the positive selection against outercoat and medullated fibers. In a few instances, selection favored lambs with poorer face and color scores.

SELECTION PRACTICED ON FINEWOOL CROSSBRED WEANLING LAMBS

Year & Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent Saved
		Heritability	21%	6%	30%	46%	4%	11%			
1953											
12	Rams	Selection Differential	7.97	-.07	.61	-.05	.54	.45	.06	.05	16.67
		Relative Emphasis	.88	-.16	.30	-.15	1.10	.83	.26	.29	
		Expected Genetic Gain	1.674	-.004	.183	-.023	.022	.050	-	-	
	Ewes	Selection Differential	1.39	-.04	-.03	.03	.14	.12	.12	.11	65.38
		Relative Emphasis	.21	-.10	-.02	.07	.33	.29	.28	.35	
		Expected Genetic Gain	.292	-.002	-.009	.014	.006	.013	-	-	
Rams & Ewes		Expected Genetic Gain per Generation	.983	.003	.087	-.004	.014	.032	-	-	
13	Rams	Selection Differential	10.39	.19	-.20	.28	.33	.30	.30	.04	20.00
		Relative Emphasis	1.20	.36	-1.11	.60	.72	.56	.45	.31	
		Expected Genetic Gain	2.182	.011	-.060	.129	.013	.033	-	-	
	Ewes	Selection Differential	1.39	-.04	-.11	-.11	.23	.20	-.03	.15	50.00
		Relative Emphasis	.19	-.08	-.46	-.29	.39	.31	-.09	.28	
		Expected Genetic Gain	.292	-.002	-.033	-.051	.009	.022	-	-	
Rams & Ewes		Expected Genetic Gain per Generation	1.237	.004	-.046	.039	.011	.028	-	-	
TOTALS											
	Rams	Selection Differential	8.99	.03	.30	.09	.42	.39	.14	.05	17.86
		Relative Emphasis	1.02	.06	.15	.23	.88	.72	.32	.31	
		Expected Genetic Gain	1.888	.002	.090	.041	.017	.043	-	-	
	Ewes	Selection Differential	1.68	-.04	-.01	-.02	.19	.17	.05	.15	57.69
		Relative Emphasis	.23	-.09	.00	-.05	.37	.31	.13	.33	
		Expected Genetic Gain	.353	-.002	-.003	-.009	.008	.019	-	-	
Rams & Ewes		Expected Genetic Gain per Generation	1.120	.000	.044	.016	.012	.031	-	-	

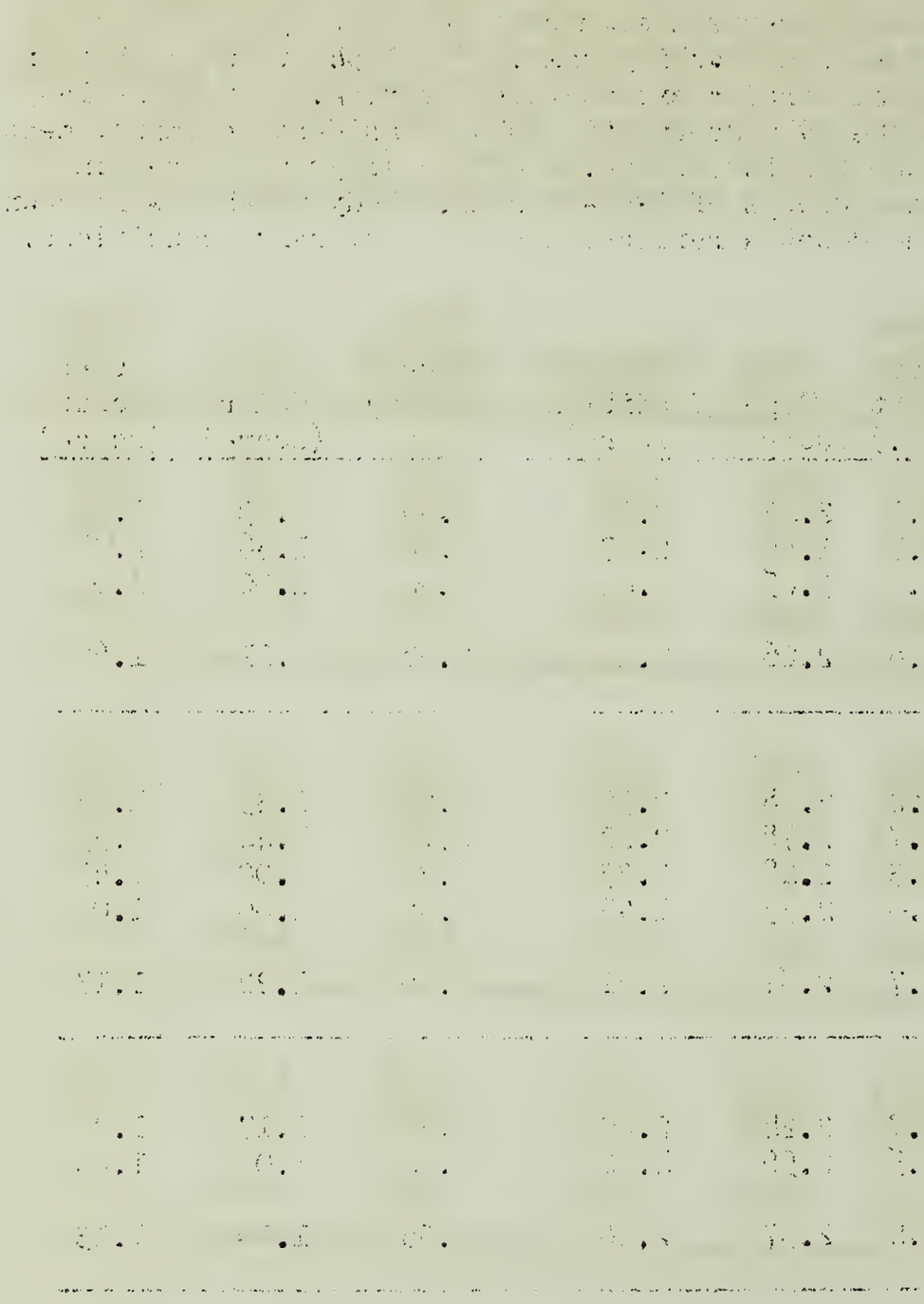
SELECTION PRACTICED ON FINEWOOL CROSSBRED WEANLING LAMBS, CONT.

Year & Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent Saved
		Heritability	21%	6%	30%	46%	4%	11%			
1954											
12	Rams	Selection Differential	6.66	-.05	.84	.09	.38	.42	-.15	.18	27.27
		Relative Emphasis	.85	-.13	.41	.27	.70	.85	-.37	.58	
		Expected Genetic Gain	1.399	-.003	.252	.041	.015	.046	-	-	
	Ewes	Selection Differential	5.49	-.13	-.39	.02	.43	.36	.05	.46	57.89
		Relative Emphasis	.51	-.29	-.29	.10	.65	.53	.22	.50	
		Expected Genetic Gain	1.153	-.008	-.117	.009	.017	.040	-	-	
Rams & Ewes		Expected Genetic Gain per Generation	1.276	-.005	.067	.025	.016	.043	-	-	
13	Rams	Selection Differential	4.88	-.09	.26	-.01	.28	.40	.10	.27	31.43
		Relative Emphasis	.57	-.24	.15	-.03	.58	.76	.14	.47	
		Expected Genetic Gain	1.025	-.005	.078	-.005	.011	.044	-	-	
	Ewes	Selection Differential	2.61	.02	-.11	.03	.25	.34	.12	.33	47.06
		Relative Emphasis	.31	.05	-.05	.07	.44	.52	.36	.64	
		Expected Genetic Gain	.548	.001	-.033	.014	.010	.037	-	-	
Rams & Ewes		Expected Genetic Gain per Generation	.786	-.002	.022	.004	.010	.040	-	-	
TOTALS											
	Rams	Selection Differential	5.18	-.08	.37	.02	.31	.41	.04	.26	30.43
		Relative Emphasis	.61	-.21	.21	.05	.61	.80	.06	.50	
		Expected Genetic Gain	1.088	-.005	.111	.009	.012	.045	-	-	
	Ewes	Selection Differential	4.05	-.04	-.15	.03	.33	.35	.09	.37	50.94
		Relative Emphasis	.42	-.09	-.07	.09	.54	.52	.30	.54	
		Expected Genetic Gain	.850	-.002	-.045	.014	.013	.038	-	-	
Rams & Ewes		Expected Genetic Gain per Generation	.969	-.004	.033	.012	.012	.042	-	-	

BODY WEIGHTS AND SCORES OF FINEWOOL CROSSBRED YEARLING RAMS

The following table presents a summarization of body weights and scores of finewool, crossbred yearling rams. The 1954 group was better than the 1953 group in all traits except face covering. Here, the 1953 rams were better, but the 1954 group still show considerable improvement over the 1950-52 average for face score. Both later groups were, in general, superior to the groups of 1950-52 rams. Body weights were down somewhat and this is no doubt a reflection of the dry range conditions.

Year and Breeding Group No.	No.of Rams	Body Weight (lbs.)	Type (score)	Condition (score)	Face Covering (score)	Color (score)	Outer-coat (score)
1950	24	113.3	2.43	2.13	2.99	1.13	1.35
1951	13	113.7	1.84	2.07	3.10	1.38	2.05
1952	2	101.0	3.05	3.44	1.94	1.00	2.00
1950-52	39	112.8	2.26	2.18	2.97	1.21	1.62
1953							
Group 12	6	108.2	2.48	2.30	1.67	1.33	1.03
Group 13	3	108.7	2.78	2.22	2.06	1.44	1.33
Group T-14	3	112.3	2.48	2.33	2.33	1.00	1.45
Group T-15	3	116.0	2.33	1.93	1.56	1.00	1.00
Totals	15	110.7	2.51	2.21	1.86	1.22	1.17
1954							
Group 12	6	111.7	2.24	2.00	2.36	1.17	1.22
Group 13	4	113.5	2.56	4.14	2.84	1.00	1.00
Totals	10	112.4	2.37	2.06	2.55	1.10	1.13



FLEECE CHARACTERISTICS OF FINEWOOL CROSSBRED YEARLING RAMS

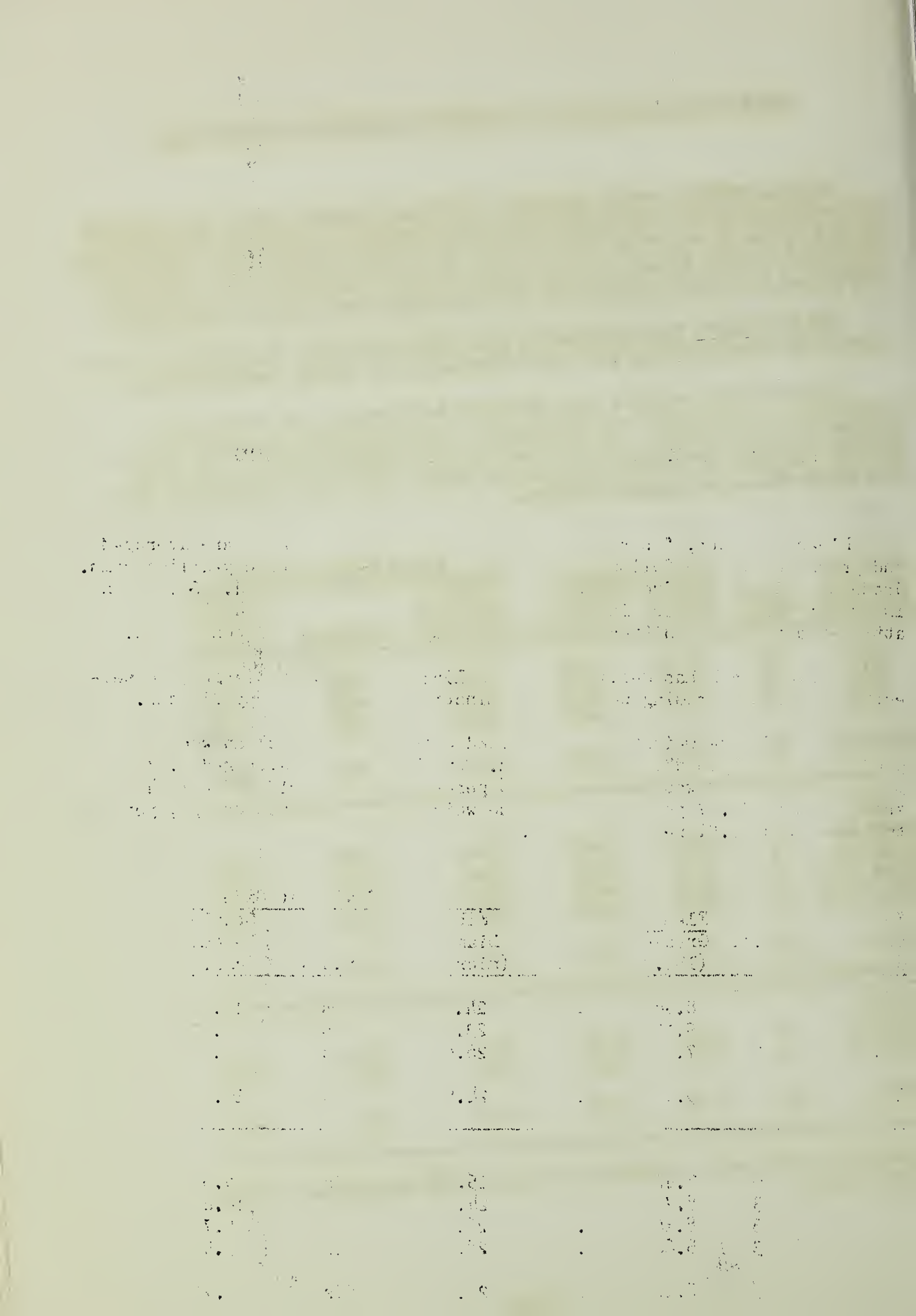
Fleece weights, fiber diameter, grade and staple length are averaged and presented in the following table for finewool, crossbred yearling rams. Grade has fluctuated from 58's to 64's from 1950 through 1954. Selection is against coarse fibers in this group and the fluctuation can likely be attributed to yearly differences in feed supply and weather conditions.

Staple length has declined in both 1953 and 1954, due largely to selection for finer grading wool and elimination of hairy, kempy fleeces.

Grease fleece weights have declined both years, but clean wool production, or "yield", has increased. The 1953 groups averaged 1.07 pounds less grease wool, yet had 3.75 percent higher yield. The 1954 groups averaged .77 pounds less grease weight than the 1953 groups, yet the yield was 12.81 percent higher.

Year and Breeding Group No.	No. of Rams	Fleece Weights		Fiber Traits at Side		
		Grease (lbs.)	Clean (lbs.)	Fiber Diameter (microns)	Grade*	Staple Length (cms.)
1950	24	8.96	4.89	24.6	60s	11.5
1951	13	9.84	3.36	23.9	62s	9.5
1952	2	7.71	3.86	26.6	58s	9.2
1950-52	39	9.19	4.33	24.5	60s	10.7
1953						
Group 12	6	7.42	3.79	25.1	60s	9.6
Group 13	3	8.71	4.21	24.9	60s	10.4
Group T-14	3	8.16	4.05	26.1	58s	9.7
Group T-15	3	8.86	4.82	28.9	54s	9.4
Totals	15	8.12	4.13	26.0	58s	9.7
1954						
Group 12	6	7.64	4.91	22.0	64s	9.1
Group 13	4	6.91	4.33	20.7	70s	7.8
Totals	10	7.35	4.68	21.5	64s	8.6

* Grade for all years converted to latest ASTM standards, adopted June 1953.



BODY WEIGHTS AND SCORES OF FINEWOOL, CROSSBRED YEARLING EWES

The body weights and scores of finewool, crossbred yearling ewes are presented in the following table. In comparing the latter two years of 1953 and 1954, it is obvious that the 1954 ewes are superior and gains have been made for each trait. Both latter years are superior to the 1950-52 averages in all traits except type and condition. Here, the 1953 ewes fall below the 1950-52 average. A very definite gain has been made in face, color and outercoat scores. The most important trait, body weight, averages from 2.5 to 6.0 pounds heavier than the 1950-52 average.

Year and Breeding Group No.	No. of Ewes	Body Weight (lbs.)	Type (score)	Condition (score)	Face Covering (score)	Color (score)	Outer-coat (score)
1950	49	81.8	2.22	2.13	2.76	1.14	1.68
1951	35	55.4	2.47	2.49	3.03	1.20	2.01
1952	21	87.0	2.49	2.29	2.09	1.90	1.39
1950-52	105	74.0	2.36	2.28	2.72	1.31	1.73
1953							
Group 12	28	77.8	2.37	2.41	1.98	1.26	1.35
Group 13	13	73.1	2.71	2.62	2.10	1.13	1.51
Group T-14	6	79.2	2.54	2.31	2.22	1.11	1.33
Group T-15	5	75.0	2.47	2.40	2.13	1.00	1.20
Totals	52	76.5	2.48	2.45	2.05	1.19	1.38
1954							
Group 12	17	80.7	2.13	1.93	2.14	1.00	1.17
Group 13	10	78.7	2.27	1.97	2.07	1.20	1.22
Totals	27	80.0	2.18	1.94	2.11	1.07	1.19

FLEECE CHARACTERISTICS OF FINEWOOL, CROSSBRED YEARLING EWES

In studying the fleece characteristics of finewool, crossbred yearling ewes of 1953 and 1954, several factors are outstanding. Grease fleece weights of 1953 and 1954 are both lower than the 1950-52 average for this trait. In spite of the lowered grease weight, the percent of yield, or clean wool production, is increased. The 1953 yearling ewes averaged .82 pounds less grease wool than the 1950-52 average, yet produced a yield of 6.27 percent more clean wool. The 1954 ewes had .09 pounds more grease wool than the 1953 ewes, and produced 0.59 percent higher yield. This is also well over the 1950-52 average by 6.86 percent more clean wool from .73 less grease wool. This increased production has been gained while still maintaining a grade of 70's and holding staple length approximately the same. Staple length was down 0.9 centimeters in 1954.

Year and Breeding Group No.	No. of Ewes	Fleece Weights		Fiber Traits at Side		
		Grease (lbs.)	Clean (lbs.)	Fiber Diameter (microns)	Grade*	Staple Length (cms.)
1950	49	8.70	3.64	20.9	70s	9.1
1951	35	5.00	1.90	17.2	80s	9.2
1952	21	6.52	2.89	24.5	60s	6.3
1950-52	105	7.03	2.91	20.4	70s	8.6
1953						
Group 12	28	6.24	2.99	20.9	70s	8.4
Group 13	13	6.01	2.79	19.6	70s	8.9
Group T-14	6	6.32	2.94	20.5	70s	8.4
Group T-15	5	6.43	3.37	20.4	70s	8.6
Totals	52	6.21	2.96	20.5	70s	8.6
1954						
Group 12	17	6.50	3.18	21.6	64s	7.8
Group 13	10	5.97	2.81	20.9	70s	7.6
Totals	27	6.30	3.04	21.4	64s	7.7

* Grade for all years converted to latest ASTM standards, adopted June 1953.

RESEARCH PROJECT 4

DEVELOPMENT OF AN EFFICIENT METHOD OF SELECTING ANIMALS USED IN THE PROGRAM OF THE SOUTHWESTERN RANGE AND SHEEP BREEDING LABORATORY.

A SELECTION INDEX FOR NAVAJO CROSSBRED RANGE LAMBS

The work concerned with this project was the construction of a selection index for the weanling lambs of the coarsewool breeding group. Component parts of the index included heritability values of the traits considered, phenotypic and genetic correlations among them, and their relative economic values.

Data for this study included 1078 dam-offspring pairs of Navajo and Navajo crossbred sheep. Six traits were measured when the lambs were approximately 120 days of age. Weaning weights, staple length, medullated fibers and fiber diameter were measured in pounds, centimeters, percent and microns, respectively. Body type and condition (degree of fatness) were evaluated by scores.

The environmental factors for which the traits were corrected were age of dam, type of birth and rearing, sex and age of lambs.

Heritabilities of weaning weight, medullation and fiber diameter were found to be 0.21, 0.64, and 0.30 percent, respectively, and are sufficiently high to make mass selection reasonably effective. Heritability values for staple length, body type and condition were 0.06, 0.04, and 0.11 percent, respectively, and are low enough that mass selection would be relatively ineffective.

The traits most highly correlated with one another, phenotypically, were weaning weight and type, weaning weight and condition, body type and condition, and medullation and fiber diameter. However, all correlations, except those between staple length and type, staple length and condition, and staple length and weaning weight, were large enough to be statistically significant.

A Selection Index for Navajo Crossbred Range Lambs, continued.

The genetic correlations among the traits were:

	Body Type	Condition	Staple Length	Medullation	Fiber Diameter
Weaning Weight	-0.26	-0.09	-0.10	-0.13	1.19
Type		-2.17	0.68	0.22	0.24
Condition			-2.29	0.24	0.26
Staple Length				-0.15	0.36
Medullation					0.45

Three of the above correlations are larger than unity, indicating large sampling errors are associated with these correlations. Some of the correlations are indicative of antagonism between desirable traits in sheep production. Selection for heavier lambs gives shorter staple, and selection for longer staple or increased fiber diameter results in an increase in medullated fibers.

Relative economic values of the traits were calculated from long time price averages for wool and lambs. These relative economic values were: weaning weight, pounds (13.41); body type, score (31.00); condition, score (31.00); staple length, cm. (13.12); medullation, percent (3.50); fiber diameter, microns (2.00), for each unit change in the trait.

Using information concerning the heritabilities, phenotypic and genetic correlations and the relative economic values, the selection index was calculated. This index was:

I = 1.00 weaning weight, + 7.76 type + 9.10 condition - .84 staple length - 1.11 medullation + 4.96 fiber diameter.

The rate of improvement from selecting weanling lambs on the basis of this index will likely be slow as evidenced by the calculated expected genetic gains per generation. However, progress can be expected to be more rapid with, than without an index, as the index consistantly emphasizes the traits which are highly heritable and which have high economic value.